

US EPA RECORDS CENTER REGION 5



478678

EPA 903/B-97-006

Hazard Evaluation Handbook

A Guide to Removal Actions Fourth Edition

Prepared by the Roy F. Weston
Site Assessment Technical Assistance Team
for the
U.S. Environmental Protection Agency
Region III Superfund Removal Branch
Under Contract #68-S5-3002



October 1997

TABLE OF CONTENTS

Introduction	1
Safety	5
Sources of Information	7
Conducting a Removal Assessment	11
General Hazard Recognition	19
Fire/Explosion Checklist	22
Drum Site Checklist	24
Lagoon Checklist	27
Landfill Checklist	29
Chemical Storage Checklist	32
Laboratory Checklist	34
Industrial Facility Checklist	37
What's Wrong With This Picture?	40
Emergency Removal Guidelines	49
Emergency Removal Guideline Concentrations	52
Removal Numeric Action Levels for Drinking Water	71
Appendices	
1. Toxicology	A93
2. Environmental Media	A113
3. Sampling and Basic Data Interpretation	A121
4. Container Silhouettes	A135
5. Guide to DOT and NFPA Placards	A151
6. Integrating Removal and Remedial Site Assessment Investigations	A167
Index	

Introduction

This book is the fourth edition of a guidebook for U.S. EPA project managers, inspectors, and others to help them view a project site from a multimedia perspective and to recognize potential emergency or removal conditions that may not be obvious. It is essential that the project manager or inspector question everything at a project site in terms of the imminent threat posed to human health and the environment.

According to the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300.420 (b) and (c), among the goals of a remedial preliminary assessment and of a site investigation are to determine if there is any potential need for removal action, and, if the assessment or investigation indicates that a removal action is warranted, to initiate a removal site evaluation pursuant to 40 CFR Part 300.410. Removal actions are warranted in unstable or potentially unstable situations that pose immediate threats to public health and the environment. Examples of such threats are weathered, leaking drums; potentially explosive substances; damaged buildings or other structures with a high potential for causing hazardous substances to be released from containment; and so forth. The purpose of this book is to help Remedial Project Managers understand the processes involved in a removal site evaluation and recognize the potential sources of immediate hazards at various types of sites. Such recognition is important not only to fulfill the mandates of the NCP,

but also to maintain maximum site safety and security during remedial actions.

Many sites, such as those being evaluated for the National Priorities List (NPL), are examined first by the Site Assessment Program, not by the Removal Program, so it is important that these sites be examined in light of their potential for causing imminent threats. Other sites undergo emergency removal actions by the Removal Branch first and then are transferred to other programs for additional action. During the subsequent transition period, conditions that were stable at the end of the removal response may have deteriorated so that an imminent threat is posed to the public or to the environment. Remedial sites are of concern because the remedial process can take years, during which weathering and wearing of storage and containment facilities can occur. The NPL Site Certification process requires the periodic evaluation of remedial sites. These evaluations should include an assessment of the need for a removal action.

A companion to this guide is the *Disposal Handbook: A Guide to Evaluating Hazardous Waste at a Superfund Site for Disposal*, which is designed for use once a removal action has been determined to be necessary. The *Disposal Handbook* takes a quantitative approach to evaluating known threats at a hazardous waste site, whereas the *Hazard Evaluation Handbook* takes a qualitative approach to determining whether a threat exists and, if so, the nature of the threat.

This book is meant only as a guide to the possible sources of harm presented by various types of sites; it is not an exhaustive study. Instead, the purpose of the book is to encourage project managers and others to examine a site from several different perspectives in evaluating potential hazards.

Acknowledgments

This book was prepared by the Region III Site Assessment Technical Assistance (SATA) Team under the coordination of the Superfund Removal Branch, U.S. EPA Region III. Many EPA personnel and SATA members made direct and indirect contributions to this project. The project could not have been successfully completed without the assistance of the EPA and SATA personnel involved.

Safety

Certain safety precautions should be considered before entering any area that is suspected to be contaminated with hazardous substances. EPA's Standard Operating Safety Guides, November 1984, as well as the specific site health and safety plan should be followed to prevent short-term exposure and injury and the long-term effects of multiple short-term exposures.

- **Review background information about the facility prior to making a site visit. A background search may provide such useful information as the names of any process chemicals used at the facility, contact names, and site-specific hazards and may assist field personnel conducting the assessment.**
- **Draft a site health and safety plan to address all chemical, physical, biological, and radioactive hazards associated with the site. Modifications to the safety plan can be made as additional information is collected.**
- **Conduct an initial survey of the site from a safe distance away to determine if there are any visible hazards that should be addressed or avoided when entering the site. If the contaminants are known, it is possible to gather information from the numerous reference sources available, prior to going on the site.**

- When making an entry into a site where the materials are unknown, high levels of protection (Level B or higher) are recommended until sufficient data has been collected to determine that lower levels of protection are sufficient. During the assessment, the entry team will use direct air monitoring equipment to check for radiation, combustible gases, and volatile organic and inorganic vapors. Multimedia (air, water, and soil) samples should also be collected to determine actual concentrations of the contaminants on site.
- Based on the initial survey, select the proper type of personal protective equipment to safely perform tasks required for further site assessment. Personal protection may include a self-contained breathing apparatus (SCBA) or air-purifying respirator (APR), chemical protective coveralls, chemical-resistant gloves and boots, a hard hat, and safety goggles. The purpose of the protective equipment is to minimize the risk of exposure to hazardous substances through inhalation, ingestion, or skin contact.
- Personnel working on site must have completed a minimum level of OSHA-required training per 29 CFR 1910.120.
- Ensure that all persons entering the site read and understand the site health and safety plan in order to limit the number of injuries. As new threats are encountered and the site work plan is revised, the safety plan must be amended to reflect these changes.
- Determine if a confined space permit is required.

Sources of Information

Questions about the hazards posed by a site and whether a removal response is appropriate can be answered by the EPA Region III Superfund Removal Branch. Call the following people for information:

Regional Response Center - (215) 566-3255

An On-Scene Coordinator from the Superfund Removal Branch is on duty outside of normal working hours and can be reached through the Regional Response Center to answer questions.

Charles Kleeman, Section Chief - (215) 566-3257

Removal Response Section (3HW31)

Superfund Removal Branch

Karen Melvin, Section Chief - (215) 566-3275

Removal Enforcement and Oil Section (3HW32)

Superfund Removal Branch

David Wright, Section Chief - (215) 566-3293

Site Assessment and CEPP Section (3HW33)

Superfund Removal Branch

Questions about the degree of toxicity posed by a substance and its possible effects should be referred to the EPA Region III Superfund Technical Support Section (3HW41). Call the following people for information:

Bill Belanger, Regional Radiation Representative (3AT32) - (215) 566-2082

Eric Johnson, Section Chief (3HW41) - (215) 566-3313

Toxicological information may also be obtained from:

Samuel Rotenberg, Toxicologist - (215) 566-3396
RCRA Integrated Management and Support Section (3HW70)

Additional information can be obtained from:

American Association of Railroads - (202) 639-2100

The association provides assistance at sites involving rail shipments of hazardous materials.

Centers for Disease Control - (404) 633-5313 (24 hours)

The CDC provides assistance in emergencies involving bacterial agents or infectious diseases.

Chemical Emergency Preparedness Program - (800) 535-0202

This hotline provides information on reporting of hazardous substances for community planning purposes.

CHEMTREC - (800) 424-9300 (24 hours)

CHEMTREC provides information concerning materials involved in hazardous materials incidents. CHEMTREC can also contact manufacturers, shippers, or other parties who may be able to provide additional assistance. A supplement to CHEMTREC is the HIT (Hazard Information Transmission) program, which provides a hard copy of hazard data. Non-emergency service can be obtained from CHEMTREC by calling (800) 262-8200, between 8 a.m. and 9 p.m.

EST. CHEMTREC is operated by the Chemical Manufacturers Association.

**National Animal Poison Control Center - (217) 333-3611
(24 hours)**

The center is operated by the University of Illinois and provides assistance at sites involving suspected animal poisonings or chemical contamination.

**National Pesticide Telecommunications Network -
(800) 858-7378**

The network provides information about spill handling, disposal clean-up, and health effects of pesticides.

Nuclear Regulatory Commission, King of Prussia, PA - (610) 337-5000

HQ National Operation Center (301) 816-5100

These numbers provide information about radiation concerns.

Safe Drinking Water Hotline - (800) 426-4791

This hotline provides information about the public water supply program, policy, and technical and regulatory items.

**Solid Waste and Hazardous Waste (RCRA) and Superfund -
(800) 424-9346**

This hotline provides information about the Resource Conservation and Recovery Act and Superfund. It is operated by EPA.

Texas Tech University Pesticide Hotline - (800) 858-7378

The hotline provides emergency information in pesticide-related incidents.

**TSCA and Asbestos Technical Information and Referral -
(202) 554-1404**

This hotline provides information on the Toxic Substances Control Act and on asbestos.

US Department of Transportation Hotline - (800) 467-4922

The hotline provides information and assistance concerning the hazardous materials regulations found in the Code of Federal Regulations Title 49.

Computer Resources**TOXNET**

TOXNET, managed by the National Library of Medicine, provides access to data bases on toxicology and related issues. Five integrated data base modules are accessible: the Hazardous Substances Data Bank (HSDB), Registry of Toxic Effects of Chemical Substances (RTECS), Chemical Carcinogenesis Research Information System (CCRIS), Directory of Biotechnology Information Resources (DBIR), and Environmental Teratology Information Center Backfile (ETICBACK). Call (301) 496-6531 for account information.

CHEMICAL INFORMATION SYSTEMS INC

CIS provides access to about nine different data bases. Among the data bases are the Oil and Hazardous Material/Technical Assistance Data System (OHMTADS), the Chemical Hazard Response Information System (CHRIS), and the MERCK index. CIS also provides access to the SPHERE family of components sponsored by the U.S. EPA Office of Toxic Substances, including DERMAL, ENVIROFATE, and ISHOW. Call (800) CIS-USER for account information.

CAMEO - RIDS

The Computer-Aided Management of Emergency Operations (CAMEO) program provides response information and recommendations for over 4000 commonly transported chemicals, an air dispersion model, and components for emergency response planning. Call (800) 99CAMEO for account information.

Internet Resources

For information on numerous topics including pollution control and remediation technologies relating to air, water, and hazardous waste start at EPA's web site at the following address: <http://www.epa.gov/>

Conducting a Removal Assessment

Certain safety precautions should be considered before entering an area of any description that is suspected to be contaminated with hazardous substances. The National Contingency Plan, 40 CFR Section 300.410, gives the minimal procedures for conducting a removal site evaluation, which "includes a removal preliminary assessment and, if warranted, a removal site inspection." According to the NCP:

300.410(c)(1) The lead agency shall, as appropriate, base the removal preliminary assessment on readily available information. A removal preliminary assessment may include, but is not limited to:

- (i) Identification of the source and nature of the release or threat of release;**

This may be as easy as reading the U.S. Department of Transportation (DOT) placard on a tank truck. In the case of a hazardous waste site with hundreds of possibly unlabeled drums of different chemicals, recognition of the source and nature of the threat posed requires use of all information available; e.g., historical data, visual observation, monitoring data, sample data, package labels, shipping manifests, and witnesses.

- (ii) **Evaluation by ATSDR or by other sources, such as state public health agencies, of the threat to public health;**

In order to evaluate the level of threat that a site poses to public health, ATSDR (Agency for Toxic Substances and Disease Registry) requires a report that describes the site and its history; lists the substances present on site and the quantity of contaminated material in different media (soil, water, air); describes the relationship between the site and such environmental pathways as groundwater, surface water, soil, sediment, and air; and provides documentation of quality control/quality assurance for supporting sample data. Similar reports can be prepared for EPA toxicologists and other public health officials so they can evaluate the degree of threat posed by a site.

- (iii) **Evaluation of the magnitude of the threat;**

Evaluation is determining the actual or potential impact of a threat to public health and welfare and to the environment. To evaluate the magnitude of a hazardous materials site, all substances must be identified, their concentrations determined, and their dispersion pathways established. Then, risk can be assessed on the basis of exposure or the threat of exposure to the public and the environment.

- (iv) **Evaluation of factors necessary to make the determination of whether a removal is necessary; and**

The eight criteria for a removal are set forth in Section 300.415 of the NCP. These criteria are qualitative in nature, and it is not necessary that all of them be satisfied for a removal to be initiated. The criteria are discussed below.

- (v) **Determination of whether a nonfederal party is undertaking proper response.**

Research whether state and/or local agencies or the potentially responsible party (PRP) have taken action to mitigate conditions at the site.

300.410(c)(2) A removal preliminary assessment of releases from hazardous waste management facilities may include collection or review of data such as site management practices, information from generators, photographs, literature searches, and personal interviews conducted, as appropriate.

300.410(d) A removal site inspection may be performed if more information is needed. Such inspection may include a perimeter (i.e., off-site) or on-site inspection, taking into consideration whether such inspection can be performed safely.

Initial entry personnel should determine the presence of any hazards that may affect response personnel, the public, and the environment; verify existing information and obtain additional information about the site; evaluate the need for prompt action to mitigate any situation on-site; and collect information to establish safety requirements for additional personnel entering the site.

NCP Criteria For Initiating A Removal Action

Section 300.415 of the NCP sets forth the criteria for determining whether a removal action is warranted. If the site meets one or more of the criteria, a removal action may be necessary.

300.415(b)(2) The following factors shall be considered in determining the appropriateness of a removal action pursuant to this section:

- (i) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;**

Determine whether the site poses a direct exposure threat. Look for evidence of children playing in or near the site. Look for evidence of people walking or riding through the area, possibly stirring up contaminated dust. Check for schools, retirement communities, hospitals or other institutions nearby with sensitive populations that may be affected by site

Explore whether contaminated runoff from the site enters nearby streams or impoundments. Look for wells in the vicinity of the site that are affected by groundwater contaminants. Determine whether the contaminants are likely to enter the food chain through biouptake.

- (ii) **Actual or potential contamination of drinking water supplies or sensitive ecosystems;**

Determine whether the release affects, or has the potential to affect, a groundwater aquifer or surface waterway used for drinking water. Check for any fragile natural areas (e.g., the habitat of an endangered species; wetlands) that may be affected by contaminants from the site.

- (iii) **Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release;**

Determine how structurally secure containers are. Look for any signs of weathering or structural instability. Based on the condition of any containers and the quantity of material present, determine whether an uncontrolled release is an imminent threat.

- (iv) **High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;**

Look for visible discoloration of the soil and for standing pools of discolored liquid. Look for any dead or dying vegetation; it may imply the presence of soil contamination that is not visible. Determine the direction of runoff.

- (v) **Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;**

Determine whether precipitation can initiate a release (e.g., a lagoon overflow) or cause contaminants already released to migrate. Check for any containers that are exposed to the weather, which facilitates structural deterioration.

(vi) Threat of fire or explosion;

Check for any flammable/explosive substances that may be present, including any initially stable substances that may have deteriorated to the point of being explosively unstable. Check for the presence of strong oxidizers. Determine whether any incompatible substances are stored together. Examine the history of the site for incidences of accidental fire, explosion, or arson.

(vii) The availability of other appropriate federal or state response mechanisms to respond to the release;

Ascertain whether other federal or state agencies can provide resources to mitigate the release or threat of release.

(viii) Other situations or factors that may pose threats to public health or welfare or the environment.

Be alert for any other condition, in addition to the ones specifically given in the NCP criteria, that may pose an imminent threat.

Conducting a Removal Preliminary Assessment and Site Inspection

PRELIMINARY ASSESSMENT

Before site entry, the investigation team should gather and review information about site activities and the chemicals used and/or generated so that hazards can be evaluated to the extent possible and preliminary controls established to protect initial entry personnel. This preliminary evaluation should provide the following information:

- The location and approximate size of the site.
- The site history, especially waste disposal history.
- A description of the topography of the site, the number and types of structures present, and routes of accessibility. Natural wind barriers such as buildings, hills, and storage tanks should also be identified, as well as how land surrounding the site is used.

- Descriptions of the hazardous substances known or suspected to be on site, their chemical and physical properties and associated risks.
- An estimation of the types of changes that may have occurred on site as the result of aging, weathering, fire/explosion, and so forth. Changes include structural damage to buildings and containers, as well as chemical alteration of hazardous substances present. Any such changes may increase the risk to personnel entering the site.
- Pathways for dispersion of hazardous substances from the site. Potential pathways include the air, such biologic routes as the food chain, groundwater, surface water, and direct contact. Adjacent properties and the sensitivity of the surrounding environment should be considered.
- A description of the response activities or other tasks to be performed on site and an estimate of their duration.

Information can be obtained through a search of state and federal regulatory and enforcement records (including previously gathered U.S. EPA removal and remedial data and information from other EPA programs such as the National Pollutant Discharge Elimination (NPDES) System for water), local government records, the potentially responsible party's records (logbooks, shipping manifests, ledgers, etc.), interviews with adjacent property owners and previous site workers, and perimeter reconnaissance. If the preliminary off-site evaluation does not produce sufficient information to identify and quantify the suspected hazards, an initial site entry and characterization are performed.

SITE INVESTIGATION

During the site investigation, entry personnel should monitor the air for conditions that are immediately dangerous to life and health (IDLH) or that may cause serious harm. Such conditions include combustible or explosive atmospheres, oxygen deficiency, and the presence of airborne toxic substances that pose a high threat through skin absorption and/or inhalation. To supplement air monitoring, personnel should look on site for indicators of IDLH conditions. Indicators include dead animals, stressed vegetation, and bulging, fuming, hissing, or otherwise stressed containers. Be alert for the

fuming, hissing, or otherwise stressed containers. Be alert for the presence of something on site that may imply the presence of a hidden hazard; for example, the edge of one rusty drum protruding through a tangle of vines could indicate that the vines are covering a pile of drums. Personnel should also monitor for ionizing radiation and note any slip, trip, and/or fall hazards. Once the hazards on site have been evaluated and the initial safety plan revised accordingly, periodic monitoring should occur to ensure the safety of site workers during the remainder of the investigation.

It is critical that the hazardous materials on site be identified exactly to assure safe and effective field operations. Several basic clues to identification of hazardous materials include:

- **Container shape and size.** Distinctive container shapes are used for certain types of substances, so basic clues to the identity of a hazardous material can be gathered from the container in which it is stored. Refer to Appendix 4 for silhouettes of some containers used in the transportation, storage, and use of hazardous materials.
- **Markings, placards, and labels.** Identifying markings, placards, and labels, along with container shape and size, are the safest and easiest methods for determining the presence of hazardous materials. The DOT requires placards on containers used to transport 1000 pounds or more of most hazardous substances across state lines; the DOT requires placards for any amount of some particularly hazardous substances. The DOT Code of Federal Regulation, 49 CFR, gives the requirements for labeling and placarding hazardous materials within the United States. There is also a marking system administered by the National Fire Protection Association (NFPA) for fixed facility storage tanks. Refer to Appendix 5 for additional information on U.S. DOT and NFPA placards and labels.

NOTE: Remember that containers may be unlabeled or even mislabeled, either intentionally or through error. Exercise extreme caution until the presence or absence of a hazardous substance has been confirmed.

- **Senses.** The senses of sight, hearing, and smell can aid in the identification of hazardous materials. Sight and hearing are the safest senses to employ and are very valuable resources in determining the presence of hazardous materials. The sense of smell is potentially dangerous. Some materials are toxic at concentrations too low to be detected by smell, and other materials induce olfactory fatigue, so workers cannot distinguish increased concentrations. Generally, standard operating procedures state that if a worker is close enough to smell a substance, the worker is too close.

Qualitative Hazard Recognition

Qualitative hazard recognition, the realization that a hazard actually exists on site, is the most crucial part of a removal site investigation. This section contains a general checklist of questions, pertinent to every site, to provide guidance in qualitative hazard recognition. Following the general checklist is a series of drawings of specific conditions that may not occur at every site. When they do occur, these conditions require a thorough evaluation, so a detailed checklist follows each drawing. This section concludes with a modified map of an actual site. A checklist follows the site map.

Use of the general checklist should give each project manager or inspector an idea of whether a removal may be warranted and provide background information about the site. The checklists associated with the drawings should be used in making a more detailed assessment of specific hazards.

The purpose of each checklist is to direct the thinking of site investigators; the checklists are guides, not all encompassing field lists that address every condition that may be encountered.

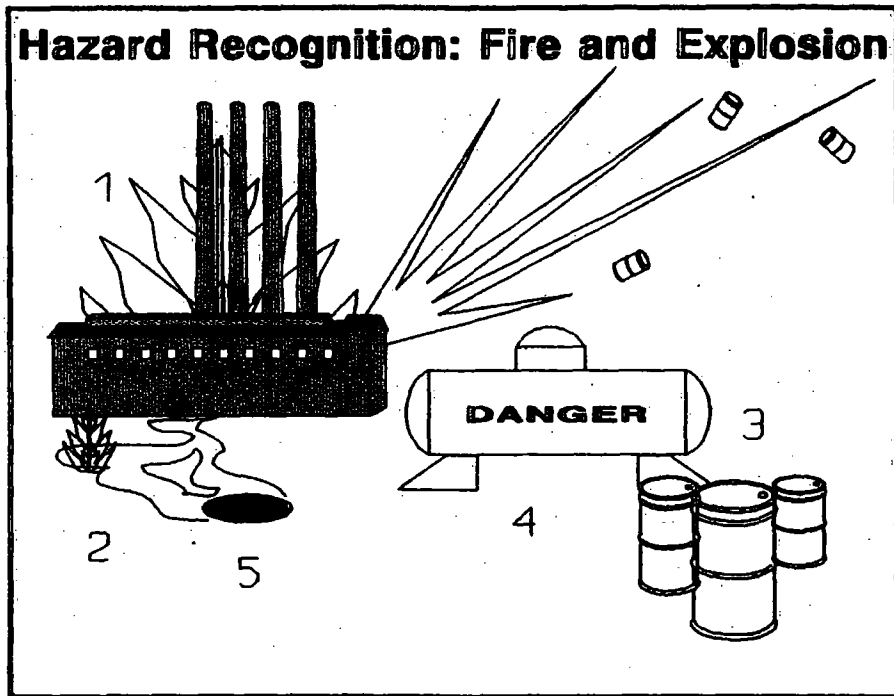
General Hazard Recognition Checklist for Each Site

- Key Points and Potential Hazards -

- 1. Note any indicators of potential exposure to hazardous substances:**
 - Dead fish, animals or vegetation.
 - Dust or spray in the air.
 - Fissures or cracks in solid surfaces that expose deep waste layers.
 - Pools of liquid.
 - Foams or oils on liquid surfaces.
 - Gas generation or effervescence.
 - Deteriorating containers.
 - Cleared land areas or possible landfilled areas. See detailed checklist on page 29.
 - Anything that appears unusual, out of the ordinary, for whatever reason.
- 2. Note the types of containers, impoundments, or other storage systems:**
 - Paper or wooden packages.
 - Metal (stainless steel, lead, etc.) or plastic barrels or drums, concrete storage containers. The composition of the container can be a clue to the contents.
 - Underground tanks.
 - Aboveground tanks.
 - Compressed gas cylinders.
 - Pits, ponds, or lagoons.
 - Other.
 - See detailed checklist on page 24, 27, 32, and 34.
- 3. Note the condition of waste containers and storage systems:**
 - Structural soundness.
 - Visibly rusted or corroded.
 - Leaking or bulging.

- Container labels indicating corrosive, explosive, flammable, radioactive, toxic, or biologically pathogenic material.
 - Presence or absence of secondary containment, such as a berm.
4. **Note the physical condition of materials on site:**
 - Physical state: gas, liquid, or solid.
 - Color and turbidity.
 - Behavior, e.g., corroding, foaming, or vaporizing.
 - Conditions conducive to splash or contact.
 5. **Identify features of the land and natural wind barriers:**
 - Buildings, large aboveground storage tanks.
 - Hills.
 - Rows of trees.
 6. **Determine the potential pathways of dispersion:**
 - Air.
 - Surface water.
 - Groundwater.
 - Land surface (direct contact).
 - Biologic routes such as plants and animals affecting the food chain.
 7. **Note any safety hazards. Consider:**
 - Condition of site structures.
 - Obstacles to entry and exit.
 - Homogeneity of the terrain.
 - Stability of the terrain.
 - Stability of stacked material.
 8. **Identify any reactive, incompatible, flammable, or highly corrosive wastes. How are they stored?**

9. Note the presence of any naturally occurring potential skin irritants or dermatitis-inducing agents or of any potentially hazardous animals. For example:
 - Poison ivy, poison oak, and/or poison sumac.
 - Poisonous snakes.
 - Stray dogs.
10. Note any tags, labels, markings, or other identifying indicators.
11. If warranted, use one or more of the following investigative techniques to locate buried wastes or contaminant plumes:
 - Electromagnetic resistivity.
 - Seismic refraction.
 - Magnetometry.
 - Metal detection.
 - Ground-penetrating radar.
12. Collect samples from:
 - Air.
 - Drainage ditches.
 - Soil (surface and subsurface).
 - Standing pools of liquids.
 - Storage containers.
 - Streams and ponds (upgradient, at suspected source, and downgradient).
 - Groundwater (upgradient, beneath site, downgradient).
13. Sample for or otherwise identify:
 - Biologic or pathologic hazards.
 - Radiologic hazards.



Fire/Explosion Scene Checklist

- Key Points and Potential Hazards -

1. Damaged Structure

- Unstable structures may pose physical hazards.
- Debris increases the risk of slip, trip, fall hazards.
- Fire often causes friable asbestos to become airborne.
- Smoke from even simple structure fires may contain many toxic chemicals.

2. Contaminated Runoff

- Runoff of water used to treat a fire will often be contaminated with chemicals released during the incident.
- The water may cause adverse reactions with reactive or unstable chemicals.
- The water may also be contaminated with combustion byproducts of chemicals stored or used at the facility.

3. Drum Storage

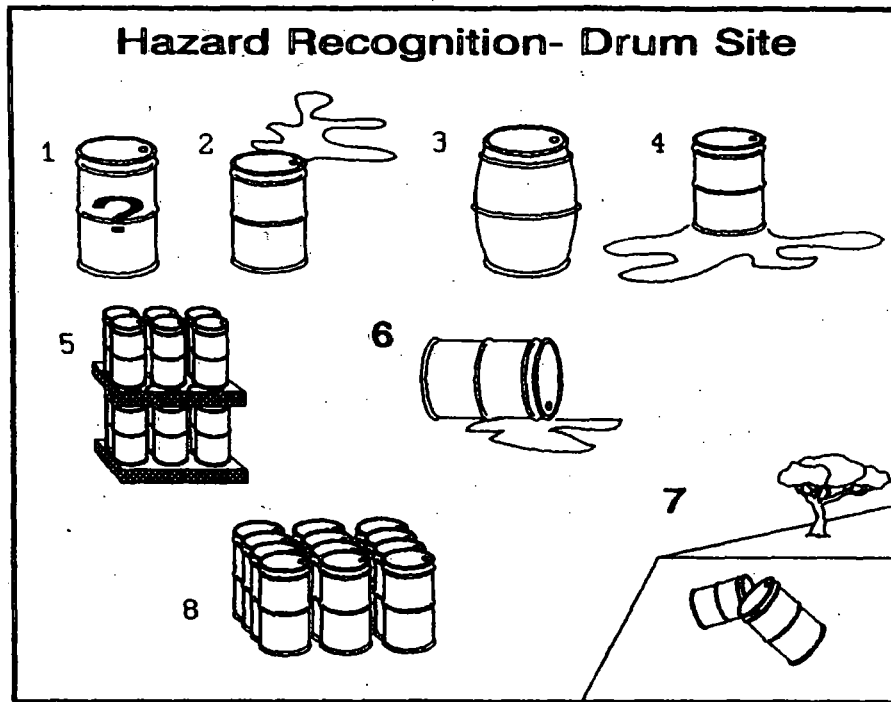
- Determine whether the drums have been impacted by either the fire, water, or chemical foam.
- Do the drums seem stable or stressed by heat or pressure?
- Can any special hazards be noted from visible label information?
- Note any physical damage caused by heavy equipment.
- Research the toxicity and physical properties of chemicals expected to be present.

4. Bulk Storage

- Determine whether the containers have been affected by either the fire, water, or chemical foam.
- Do the containers seem stable or stressed by heat or pressure?
- Are the pressure relief systems intact and actively venting?
- Are primary and secondary containment structures available and stable?
- Research the toxic and physical properties of chemicals expected to be present.

5. Drains

- Look for storm, sanitary sewer, and process water drains in the area.
- Are drain outfalls directed to a stream, river, or other sensitive area?
- Are drains connected to sump pits or other potential containment areas?
- Can drains be utilized for containment or blocked for protection if necessary?



Drum Site Checklist

- Key Points and Potential Hazards -

1. Unknown Drums

- Do not make assumptions regarding the safety of drum contents until positive identification can be made; labels may not reflect the actual drum contents.
- Shaking drums to determine whether empty or not can initiate adverse reaction.
- Seemingly empty drums can still contain toxic residues.
- Determine materials drums are made of, e.g., fiber, stainless steel, aluminum, poly, lead. These materials may give clues to the nature of the contents and the associated hazards.
- Drums containing incompatible substances may be found together. If the drums are leaking, they may pose a fire/explosion threat.

2. Vapor Release

- Not all vapors are visible. Look near bung holes for air movement similar to heat waves.
- Respiratory protection is critical to cover inhalation and ingestion exposure routes.
- Determine if vapors can be confined and concentrated due to the nature of the surrounding area or structures.

3. Bulging Drum

- Determine if bulging is caused by pressure buildup or thermal expansion/contraction.
- Bulging drums should never be opened by hand. A remote drum punch can open the drum and relieve the pressure.

4. Leaking Drum

- Contain leakage in place or block off any drains.
- Use pH paper to determine if the leaking material is corrosive.
- Any visibly stressed vegetation may indicate toxicity.
- If a smoking, fuming, or bubbling reaction is evident, it may indicate reactivity.

5. Drum Tiers

- Uneven stacking or corroded pallets/drums can present a physical hazard.
- Leaking drums on an upper tier can present a chemical hazard above the worker's head.
- Wooden pallets do not constitute a chemical barrier to prevent leaks from mixing and can pose a fire hazard in the presence of oxidizers.

6. Tipped Drum

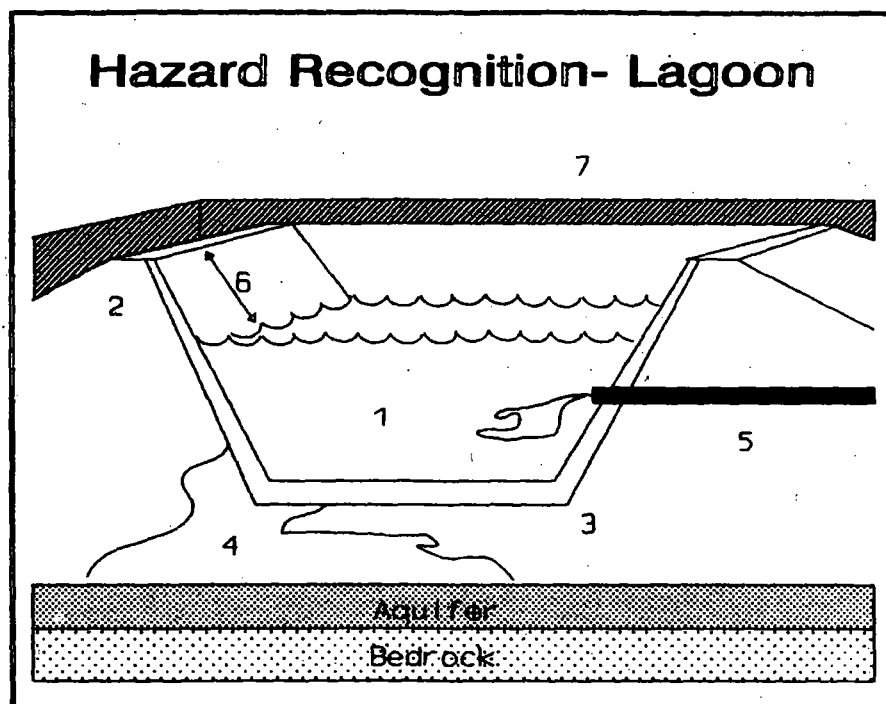
- If a tipped drum is leaking from the bung, setting the drum upright or rolling it so the bung is upright can eliminate the problem.
- A leak underneath the drum may not be visible; look for clues such as discolored soil and stressed vegetation.

7. Buried Drums

- An uneven or disturbed soil surface may indicate buried objects.
- Drum heads often rise and break through the soil surface after burial.
- Caution should be exercised when using heavy equipment in areas that have or are suspected to have buried drums.
- An excavated drum may not be structurally sound due to container deterioration.
- Data obtained from soil gas testing, magnetometer surveys, and x-ray fluorescence may indicate the presence of buried drums.

8. Packed Drums

- Do not assume that inner drums in a tightly packed area of drums contain the same chemical as the accessible drums, or that the contents are compatible.
- Large amounts of chemicals can pool beneath and between the packed drums.
- It can be extremely difficult to identify and handle, or even to reach, a leaking or fuming drum within the pack.



Lagoon Checklist

- Key Points and Potential Hazards -

1. Lagoon

- Document whether the lagoon is permitted or unpermitted.
- Determine the toxic and physical properties of the chemicals present in the lagoon.
- Note any stained soil or dead/dying vegetation in the area of the lagoon.
- Monitor for any air emissions in the vicinity of the lagoon.
- Characterize all layers of the lagoon - both liquid and solid layers.
- Check records for previous monitoring analysis of the lagoon contents.
- Research the hydrogeology of the area and the location of the water table with respect to the lagoon.

2. Containment Structure

- Note the stability of the berm construction.
- Document whether secondary containment is available in the event of failure.
- Document any seepage through the berm.
- Check whether the containment structure is adequately engineered to withstand normal stresses and strains.

3. Liner

- Check for a lagoon liner.
- Determine whether the construction materials of the liner are compatible with the contents of the lagoon.
- If possible, determine whether the liner was installed by professionals.

4. Leachate

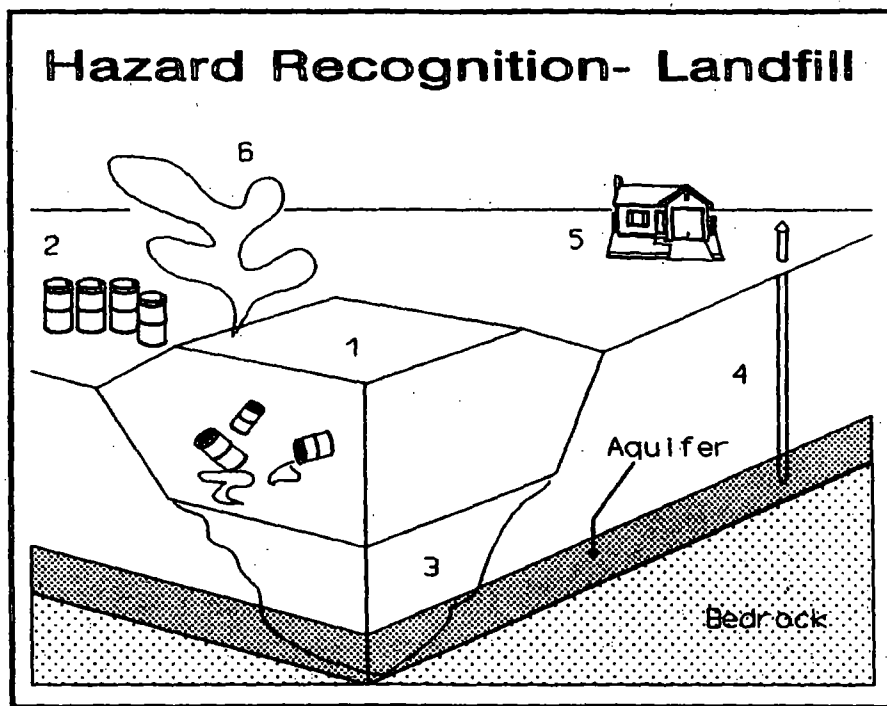
- Determine what types of chemicals can be expected to leach from the lagoon. Determine whether direct contact is a threat with any surface leachate seeps.
- Determine whether surface seeps affect any surface waters, and whether a leachate pathway to a local aquifer is available.

5. Drainage

- Identify all sources of drainage into the lagoon.
- Identify all sources of drainage out of the lagoon.
- Determine whether the lagoon liquid level rises or falls at unexpected times.
- Determine whether sufficient freeboard is available to prevent overflow of the lagoon under heavy precipitation.

6. Access Control

- Access should be restricted by a fence or other barrier.
- Look for any evidence of trespassers around the lagoon.
- Look for evidence of children playing in the vicinity of the lagoon.



Landfill Checklist

- Key Points and Potential Hazards -

1. Landfill

- Document whether the landfill is permitted or unpermitted.
- If permitted, document materials that are allowed.
- Document the history of disposal practices.
- Determine whether the landfill is lined or unlined.
- Look for evidence of illegal dumping or of dumping that is inconsistent with accepted practices.
- Research the hydrogeology of the area and the location of the water table with respect to the landfill.
- Research the toxic and physical properties of the chemicals present.

2. Staging Area

- Check for the presence of hazardous materials that are staged for disposal.
- Look for such surface contamination as stained soil or dead/dying vegetation in the staging area.
- Document whether access to the staging area is restricted by fencing or other barriers.

3. Leachate

- Determine the types of chemicals that can be expected to leach out of the landfill.
- Identify any pathways for leachate to local aquifers.
- Determine whether any surface leachate seeps pose a direct contact threat.
- Look for surface seeps that may affect surface waters.

4. Wells

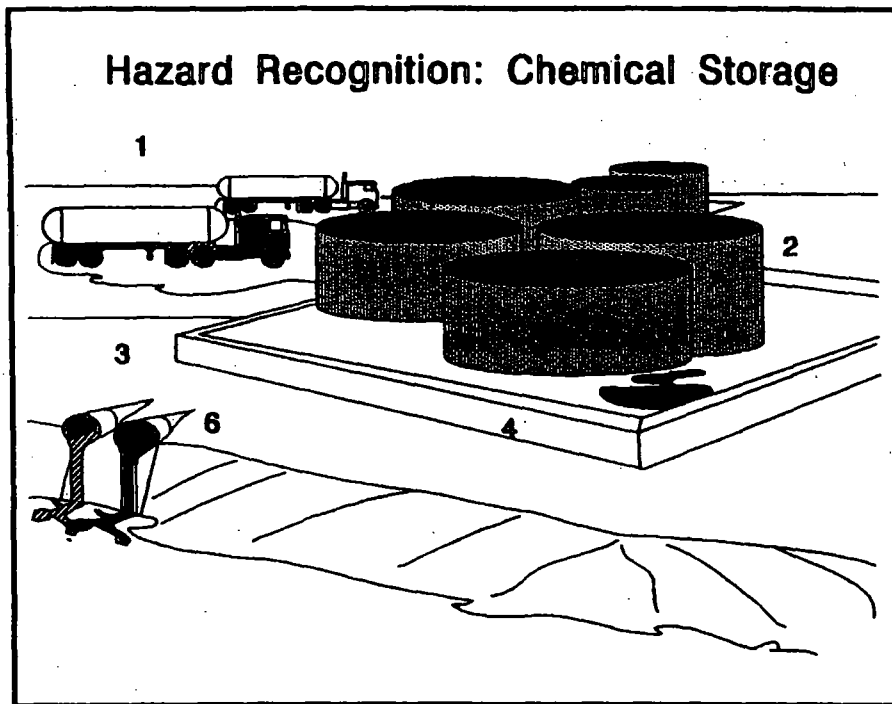
- Document any monitoring wells in the area.
- Note any drinking water wells in the area.
- Research any sample information (both past and present) that may be available for nearby wells.
- Determine whether the state has more stringent or less stringent water quality criteria than does EPA.

5. Community Access

- Look for evidence of trespassers onto the landfill.
- Look for children's play areas in the migration pathways of leachate.
- Find out if the community is aware of any actual or potential hazards posed by the landfill.
- Determine whether access to the landfill can be sufficiently restricted using signs or barriers.

6. Air Emissions

- Determine whether air emissions are controlled at the landfill.
- Check for emissions that can be detected with monitoring instruments.
- Determine whether prevailing winds carry contaminants into sensitive populations or environments.



Chemical Storage Checklist

- Key Points and Potential Hazards -

1. Transfer Points

- Determine whether bulk chemical transfer was performed on a concrete pad or over soil/gravel.
- Look for any stained soil and stressed vegetation.
- Was vehicle decontamination performed? How were decontamination agents disposed of?
- Note the condition of pipes/hoses, fittings, valves, and joints.

2. Containers

- Determine whether containers are filled or empty.
- Is the container structure compatible with the stored chemical, if the contents are known?
- If the contents are unknown, do the composition and structure of each container give clues to the contents and their associated hazards?

- Look for such indicators of structural instability as weak welds, bulging panels, missing rivets, and so forth.
- Are access portals intact; can any leakage be observed?
- Can the containers be expected to remain intact until remediation is complete?

3. Chemical Types

- Research the toxic and physical properties of the stored chemicals.
- Do signs or markings on the containers provide clues to potential dangers?
- Are incompatible chemicals stored adjacent to one another?
- Do the stored chemicals have the potential to degrade into a more hazardous form?

4. Secondary Containment

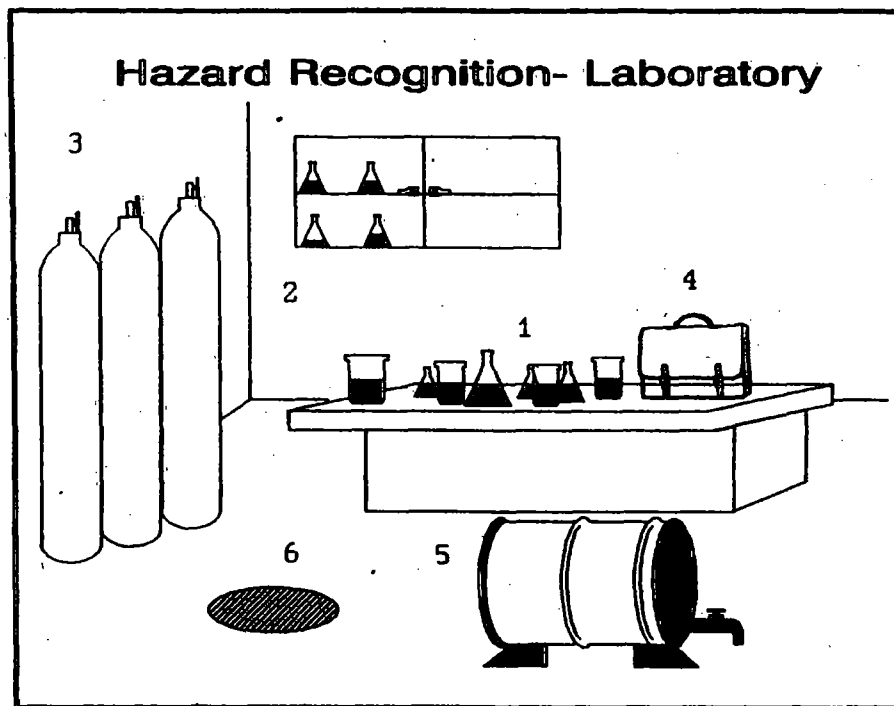
- Calculate whether the containment volume is sufficient to hold the contents of the largest primary container plus freeboard.
- Determine whether the containment structure is compatible with the chemicals present.
- Is the containment structure totally enclosing, with four walls and a floor?
- Look for any breaches, whether intentional or otherwise, present in the secondary containment structure.
- Look for any drains present in the structure.

5. Spill History

- Determine whether spills were frequent during past operations.
- Do past spills have the continuing potential to migrate off site?
- Have spills compromised the structures of either the primary containers or the secondary containment structure?

6. Drainage

- Determine whether the secondary containment structure is designed to allow for drainage of rainwater.
- Are drainage areas directed to sumps, to a treatment plant, or to the environment?
- Can the drains be blocked or otherwise closed?



Laboratory Checklist

- Key Points and Potential Hazards -

1. Unknown Chemicals

- Over time, chemicals can degrade into different, more hazardous forms.
- Older labs may have used obsolete nomenclature, so labels and papers may be confusing.
- Often, handwritten labels may be incorrect.
- Packages may become unstable over time.
- Incompatible chemicals may be stored in close proximity.
- Instruments and tubing may still contain chemicals and chemical residues.

2. Shock Sensitive Chemicals

- Many chemicals, such as ethers, are peroxidizable and so can become explosively shock sensitive over time.

- Shock sensitive chemicals can be detonated by falling off a shelf or by the shear force generated by turning the cap. Some chemicals can violently decompose spontaneously.
- Many common lab chemicals such as picric acid can, over time, become shock sensitive.

3. Cylinders

- Cylinders can contain either liquids or gases.
- They can be constructed for high pressure or low pressure use.
- Color coding is manufacturer specific and is not common to the industry.
- Cylinders can hold extremely toxic or corrosive materials.
- They should only be examined and moved by experts.
- Structural instability is not always visible from the exterior.

4. Unknown Packages

- Chemicals can be present in a variety of packaging, apart from the common flasks and glass bottles.
- Acid carboys are sometimes shipped in cardboard boxes or wooden crates.
- Radioactive materials can be shipped in metal flasks or small boxes.

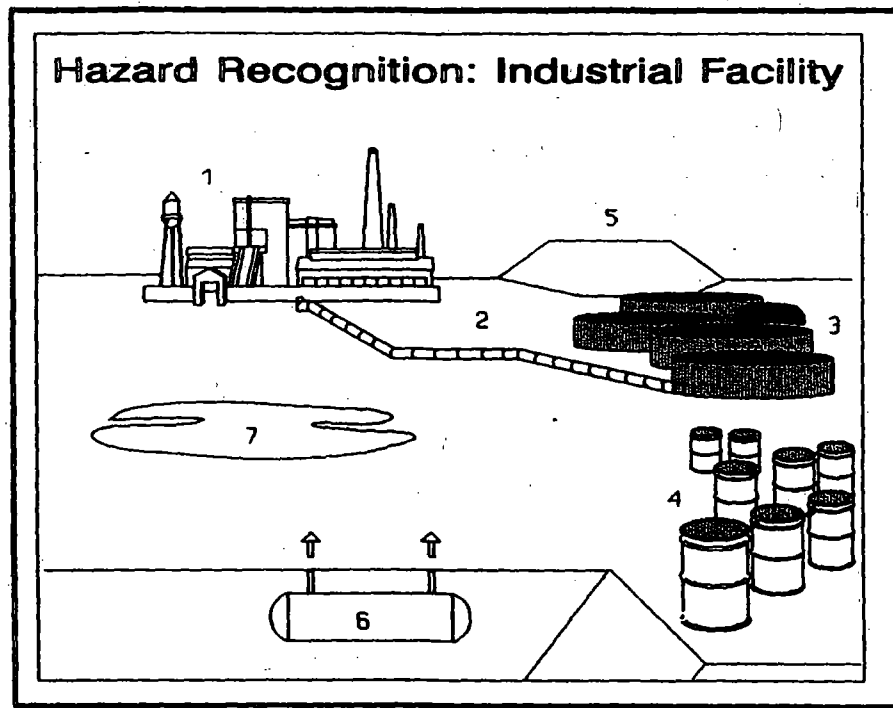
5. Drums

- Laboratories occasionally maintain chemicals in larger containers, such as 55-gallon drums.
- Larger volume chemicals would typically be caustic cleaners or solvents.
- These drums commonly rest on their sides, incorporate spigots, and have a high potential for leakage.
- Note the condition of the floor under any drums.

6. Drains

- Often, chemicals have been washed into floor drains.
- Determine whether drains are connected to sump pits or other potential containment areas.
- Pools of chemicals may accumulate in sumps.

- Incompatible chemicals may generate toxic gases in drains, sumps, or drain lines.
- Outfalls for these drains should be examined for signs of contamination.
- Are drain outfalls directed to a stream, river, or other sensitive area?



Industrial Facility Checklist

- Key Points and Potential Hazards -

1. Facility

- Evaluate the structural stability of the building(s).
- Document whether asbestos or nonasbestos insulation was used.
- Document whether PCB or non-PCB transformers were used.
- Document whether process units are filled or empty, pressurized or nonpressurized.
- Note the presence of raw materials, byproducts, and wastes in addition to chemical products.
- Obtain the history of operations, past disposal practices, and chemical spills.

2. Pipelines

- Note the structural stability of interior pipe racks and exterior feed pipes.
- Document whether asbestos or nonasbestos insulation was used.
- Note the compatibility of chemicals and pipe construction materials.
- Document whether pipelines or other types of tubing are filled or empty.
- Note the condition of valves, fittings, joints and so forth.
- Research the toxicity and physical properties of chemicals known to be used at the facility.

3. Bulk Storage Tanks

- Evaluate the structural stability of the outer skin and document any signs of physical or chemical deterioration.
- Document whether tanks are connected or disconnected to feed pipes.
- Document whether tanks are pressurized or nonpressurized, insulated or noninsulated.
- Note the condition of valves and fittings.
- Note the presence of additional heating or cooling systems to keep contents at a steady state.
- Research the toxicity and physical properties of stored chemicals.

4. Drum Storage

- Note the age of drums.
- Document whether drums are sheltered or exposed to the elements.
- Look for any signs of deterioration or stress.
- Look for any visible label or placard information.
- Look for any visible stencilled or handwritten information.
- The drum shape may potentially indicate the contents (i.e., acid carboy for corrosives or fiber drum for solids).
- If drum is bulging, determine whether bulging is due to built-up pressure or to thermal expansion/contraction.
- Document whether drums contain pure chemicals or waste materials.

- Look for any standing discolored water, stained soil, or stressed vegetation, any one of which may indicate spillage.
- Research the toxicity and physical properties of stored chemicals.

5. Landfill

- Determine whether the landfill is permitted or unpermitted.
- If permitted, document the materials known to be present.
- Research the past history of disposal practices.
- Determine whether the landfill is lined or unlined.
- Research the hydrogeology of the area and where the water table lies with respect to the landfill.
- Are there any monitoring or drinking water wells in the area?
- Research the toxicity and physical properties of chemicals present.

6. Underground Storage Tank

- Note the age of tank.
- Obtain the maintenance history.
- Research the hydrogeology of the area; note the location of the water table.
- Note the condition of exterior fittings.
- Note any seepage in the surrounding area.
- Research the toxicity and physical properties of stored chemicals.
- Document whether the tank is double lined or has cathodic corrosion protection.
- Look for evidence of frequent overflows.

7. Lagoon

- Note the stability of berm construction.
- Determine whether there is sufficient freeboard to avoid overflow.
- Is the lagoon lined or unlined?
- Research the toxicity and physical properties of chemicals present.
- Research the hydrogeology of the area; where does the water table lie with respect to the lagoon.

- Is secondary containment available?
- Note any standing discolored water, stained soil, or stressed vegetation in the area.
- Note any seepage through the berm.

What's Wrong With This Picture?

The map on page 42 is a modified version of a map of an actual removal site. Look at the map in terms of the hazard recognition checklists, pick out the hazards, then rank them according to degree of threat to the site investigation team. What immediate threats does the site pose to the environment and to the health and welfare of any residents nearby? What long-term hazards are at the site? What clues to the level of threat should the investigation team look for on site?

BACKGROUND

The All Cracked Up Battery Corp. smelted and refined lead extruded from used batteries to produce lead ingots. The facility operated for 10 years until it went bankrupt and was abandoned two years ago.

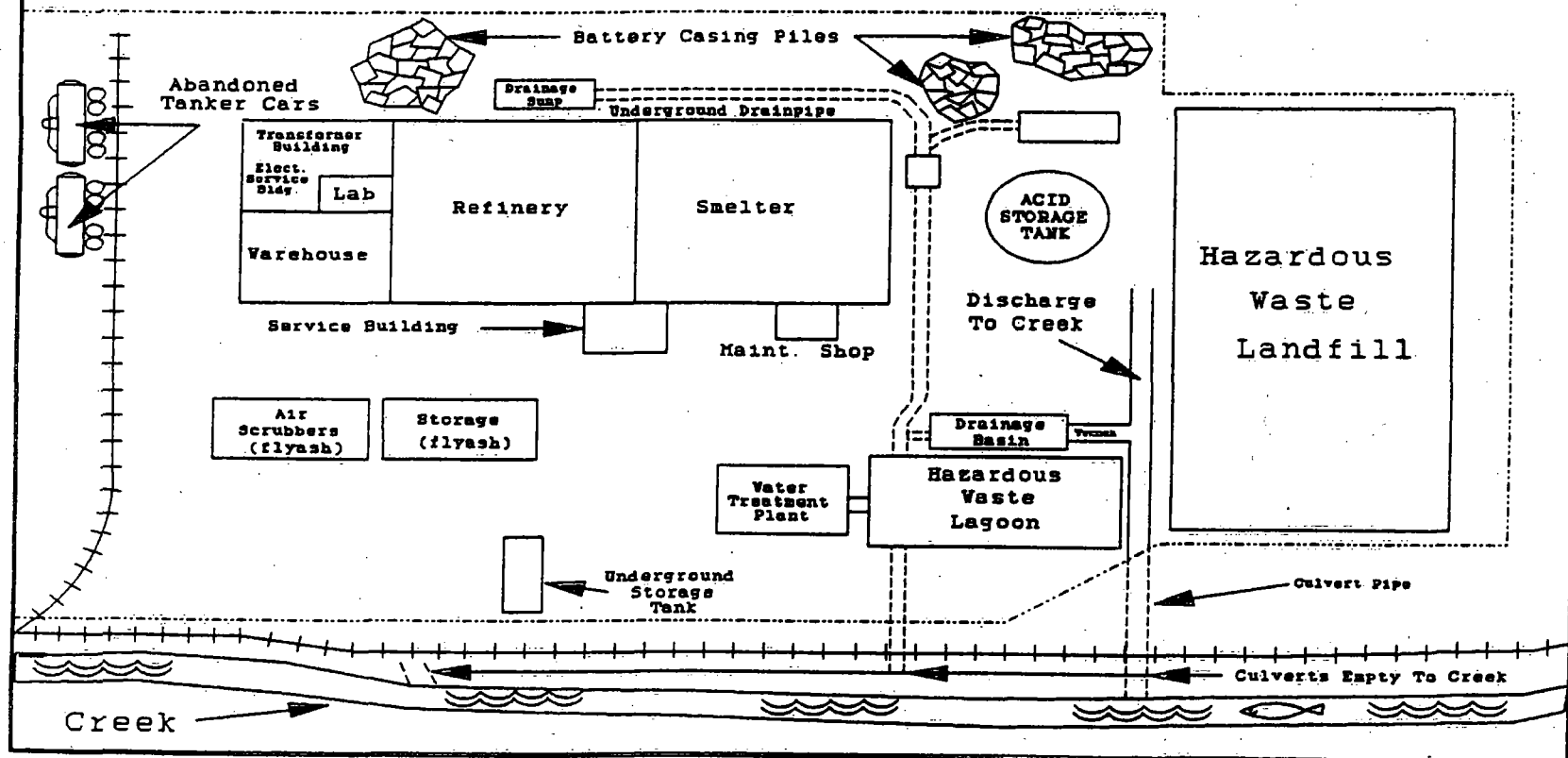
All Cracked Up received spent batteries of all sizes and had them dumped on a concrete pad to drain the acid. Battery acid and contaminated runoff from the pad were collected in a sump and then directed into a hazardous waste lagoon. After the acid was drained, the batteries were transported from the dumping area to a hammermill, where they were crushed for materials separation and cleaning. Wastewater from the cleaning process was collected in a sump and directed to the lagoon. After separation of plastics and other unrecyclable materials, the metal component of the batteries was smelted then refined. Emissions from smelters were scrubbed using a lime slurry and liquid from the lagoon. Residue from the scrubbing process was placed in a landfill on site. Emissions from the smelters and refinery were also fed through a bag house. The fly ash generated from this process was stored in a building on site. The fly ash contained heavy metals in the three percent concentration range.

Crushed battery casings from the hammermill were left in piles throughout the portion of the site north of the operations building and in the hazardous waste landfill along the east boundary fence. Surface runoff from the piles of battery casings was collected in a sump and directed to the lagoon, resulting in the migration of small battery casing chips into the sumps, drainage lines, and the lagoon itself.

The lagoon was treated with lime to neutralize its contents. Liquid from the lagoon passed into the water treatment plant, where it was treated with flocculants to remove heavy metals. The precipitates were disposed of in the landfill. The treated water was discharged into a nearby creek.

A site inspection by state officials revealed the presence of a trench between the collection sump and a drainage ditch, which facilitated the bypassing of the lagoon during periods of heavy surface runoff. Battery casing chips were found throughout the course of the drainage ditch and the creek downstream of the site.

All Cracked Up Battery Corp. Site



Piles of battery casing chips

- What types of residues can you expect to be on the chips?
- Relate these residues to past industrial activities.
- How hazardous are these residues?
- Is there any evidence that residues on these chips are migrating from the piles, into the sumps, or off site?
- How will extensive rainfall affect these piles?
- Is there vegetation around the piles; if so, in what condition is it?
- Is there any means by which persons could gain access to these piles, especially children?

Drainage sumps and underground drainpipes

- Runoff from the piles of battery casing chips flows to several drainage sumps and then into an underground drainpipe system. Is there standing water around the sumps?
- If so, is the water discolored and/or cloudy? Perform a pH test using pH paper.
- Are the drainpipes clogged?
- Where can surface runoff be expected to pool?
- Do winds generate excessive dusts in areas where water can collect? Dusts are most likely contaminated.

Liquid waste storage tank

- This container holds unknown waste material.
- Is there secondary containment around the tank? If so, is it sufficient to hold the contents of the tank?
- In what condition is the tank; is it corroded; does there appear to be structural instability?
- Is there evidence that the tank leaks?
- Is there stressed vegetation or discolored soil around the tank?
- If there is standing water near the tank, test it with a strip of litmus paper.
- Are there process lines to and from the tank? Perhaps they are underground. The lines may contain chemicals and chemical residues.
- Apply the checklist beginning on page 32 to help determine the hazards posed by the storage tank.

Hazardous waste landfill

- Is the landfill lined or unlined?
- Is there evidence of leachate seepage?
- If so, what color is the seepage; is it cloudy?
- How does the seepage test with pH paper?
- Is there access for liquids (precipitation) into the landfill?
- Did the company dispose of hazardous liquids in the landfill?
- Evaluate company records; remember that these may be deliberately incorrect.
- Is the landfill secure? Be sure that curious persons, particularly children, can not gain access.
- Use the checklist beginning on page 29 to help determine the hazards posed by the landfill.

Drainage basin and hazardous waste lagoon

- Are the drainage basin and lagoon each lined or unlined?
- How much freeboard does each one have?
- Are the process lines into each free of debris?
- Is there evidence that one or both impoundments has overflowed in the past?
- Is there standing water in the overflow trench?
- If so, what does the water look like; how does it test with pH paper?
- Are there battery casings in the overflow trench?
- Apply the checklist on page 27 to the drainage basin and lagoon.

Underground storage tank

- Note the presence of seepage along the banks of the creek, which may be indicative of a release from the storage tanks.
- Review company records. What type of fuel did the facility use? Where and how was it stored, transported and burned?
- Refer to the discussion on page 37 about chemical production facilities for additional hazards posed by USTs.

Air scrubbers and flyash storage

- Ensure that access to flyash storage is secure, particularly from curious children.
- Evaluate all piping, process lines and machinery for residual materials.
- Note the locations of drainage sumps and treatment tanks.
- Do winds generate excessive dusts? Dusts are most likely contaminated.

Abandoned tank cars

- These should be treated like storage tanks containing unknown chemicals.
- Look for any markings or placards on the outside of the cars that may indicate what they contain.
- Refer to Appendix 1 for silhouettes of railcars in order to determine what they may contain, e.g., pressurized gas, corrosive materials, etc.
- After identification, are incompatibles next to each other?
- Are the cars structurally sound and uncorroded?
- Do they appear to be leaking? Check ditches, puddles and culverts adjacent to tanks. Do they contain free-standing liquid? Test with pH paper.
- Apply the checklist beginning on page 32 to the tank cars.

Warehouse

- Locate drainage sumps, process lines, and utilities.
- Be aware of contaminated surfaces.
- Spent/old machinery poses additional hazards, e.g., laceration.
- Is the building properly ventilated? Be aware of confined space entry hazards.
- Are materials stored in the warehouse? Identify materials if possible.
- Are incompatibles stored next to each other?
- Ensure that the building is structurally sound and that adequate lighting is available.
- Watch for slip, trip, and fall hazards.

Refinery/Smelter

- Ensure that the building and large equipment (kettles, cranes, hammermill) are structurally sound.
- Locate process lines and utilities.
- Most surfaces in this area will be contaminated.
- It is likely that the atmosphere in this area is also contaminated. Watch for confined space entry hazards.
- Watch for slip, trip and fall hazards.

Service Building/Maintenance Area

- Look for chemical hazards, e.g., cleaning agents, degreasers and associated solvents, stripping agents, lubricants, etc.
- Check for storage of incompatible materials.
- Old machinery is a potential source of injury.
- Most surfaces in this area will be contaminated.
- Note the presence of gas cylinders.
- There may be a fire and explosion threat, particularly in areas with low ceilings and confined spaces.

Facility

- Thoroughly evaluate company records to be sure of industrial processes and all materials involved.
- Because this facility was involved in metals analysis and recycling, it is possible that industrial radiography may have been used. Look for radiation symbols; scan with rad meter if possible.
- How structurally sound is the building?
- What is the condition of the transformer room? Is there evidence of spilled oil which could contain PCBs?
- What is the condition of the lab? Apply the checklist beginning on page 34 to the lab.
- How secure is the facility? Is there any evidence of entrance to the facility, e.g., vandalism, children playing?

Topographics

- Is the site upgradient or downgradient to established surface water flow patterns?
- Does surface water flow through the site?

- Consult a hydrologist for groundwater concerns.
- Are there waterways nearby which may be affected?

Demographics

- What is the principal use of the land immediately adjacent to the site?
- How close is the nearest residence?
- Is there a possibility for off-site migration of contaminants to residential property?
- Are there any sensitive populations nearby, particularly children and the elderly?
- Does this site have the potential to affect the water supply of nearby residents?
- Are there any heavy use areas nearby, e.g., schools, industry, hospitals, shopping centers, farming, recreational areas, convalescent homes?
- Is there any other local industry which may have contributed to problems with this site?

After thoroughly evaluating all known aspects of the site, it is necessary to make a preliminary judgment about the degree of threat posed by this facility. At many sites, the conclusion will often be that the facility does pose a threat, but the threat should be thoroughly characterized to determine whether the site qualifies as a candidate for an immediate action, or if the site is secure enough to wait for a long-term cleanup. Assistance in these decisions can be provided by review of the NCP. If the All Cracked Up Battery Site, or another site, meets any of the criteria in the NCP for a removal action, then site conditions may be considered an emergency situation. Emergency situations do not always involve the classic fire and explosion, or oil spill. Frequently, emergency actions involve the stabilization of time critical threats until the non-time critical threats associated with the site can be addressed. Further assistance in emergency determination for a facility such as the one pictured here can be obtained through consultation with any of the Section Chiefs and On-Scene Coordinators (OSCs) in the Removal Branch.

Additional Guidance Documents

EPA (U.S. Environmental Protection Agency). 1990. "Superfund Removal Procedures Manual," OSWER Directive 9360.3-01. Office of Solid Waste and Emergency Response. Washington, DC. December.

EPA. 1992. "Guidance for Performing Site Inspections Under CERCLA." Office of Emergency and Remedial Response. Washington, DC. September.

EPA. 1991. "Removal Program Representative Sampling Guidance," Volume 1-Soil, PB892-963408. Office of Emergency and Remedial Response. Washington, DC. November.

Emergency Removal Guidelines

To help resolve incongruities in the screening process for determination of the necessity for removal actions, the EPA Region III Technical Support Section has developed the following list of emergency removal trigger guidelines. This list was designed for use only as a screening tool to aid RPMs and OSCs in the characterization of emergency threats associated with uncontrolled hazardous waste sites. This list is by no means intended to be the sole foundation for cleanup decisions. Rather, it is meant to function as just one of many sources of information that the decision maker should rely upon. Users of earlier editions of this handbook will note that the guidelines have been considerably revised, due to changes in the model used to generate the numeric values.

Toxicological values are listed in this table as absolute concentrations. That is, no calculations or manipulations of these values are necessary to use this list. To use this list, simply compare data from sampling analyses to concentrations on the list. If the results of an analysis are slightly below, equal to, or above the values listed in the table, then there is a possibility that an emergency health threat may be present at that particular site. In any situation involving the possibility of an emergency health threat, an EPA toxicologist should be consulted.

The toxicological values on this list were obtained through extensive research and evaluation of toxicological data bases, compiled through toxicity testing of the compounds, epidemiological studies, actual exposure incidences (i.e., workplace exposure, suicide attempts, accidental poisonings), and past experiences of the agency. Values derived from this broad range of investigative methods undergo review and verification before they are permitted to be published. This list, therefore, represents the most recent advances in toxicological determination and risk assessment.

We must emphasize, however, that this list has not undergone extensive peer review. It is intended for internal use only and should not be considered as EPA policy. Field personnel should use caution when referring to this list in any way that may imply EPA's endorsement of these values.

Assumptions Used in Calculating the Reference Levels

As the toxicology section of this guide explains, there is biological variation in all human populations, causing variation in the individual response to a particular dose of a toxin. Therefore, even though the response of the total population is predictable, the response of any one person within the exposed population is unpredictable. Certain assumptions about biological variation must be made to develop response models to assess risk and to predict response. The following assumptions are the basis of the model used to develop the reference values that begin on page 54:

- Carcinogen levels correspond to an upper bound lifetime risk of 1×10^{-4} . Noncarcinogen levels correspond to a hazard quotient of 10. The hazard quotient for drinking water is 1.
- Exposure comes from a single medium, except in the case of drinking water. In this case, concentrations are based on both intake of drinking water and inhalation of vapors, where appropriate.
- Exposure to residents continues for 30 years, but toxic effects from noncarcinogens may occur in as little as one year.

- For calculation purposes, adults weigh 70 kilograms and children weigh 15 kilograms; the life span is 70 years.
- Soil levels include only ingestion exposure; they omit inhalation and dermal contact.
- The amount of drinking water ingested is 2 liters per day. Compounds with Henry's Law constants greater than 10^{-4} atm m³/mol are substantially volatilized during household tap water use. Each ug/l in water produces an indoor air concentration of 0.5 ug/m³.
- Residential soil exposure for adults is based on consumption of 100 milligrams of soil per day, for 30 years. Consumption by children is 200 milligrams per day for 6 years.
- Industrial soil exposure is based on consumption of 100 milligrams of soil per day, 250 days per year, for 25 years.
- Adults inhale 20 cubic meters of air per day.
- Fish ingestion is 54 grams per day.
- These criteria are based on long-term exposure periods. Exposure to higher doses of toxic materials may produce adverse effects within a much shorter time frame, i.e., within days or weeks.

NOTE: When the numerical values were generated from the model, no attempt was made to stop a calculation greater than the total concentration. This means, for example, that if a compound has a worker soil ingestion value over 1 million mg/kg (1 million parts per million), then from an emergency perspective the compound does not pose a toxic threat to workers via soil ingestion. Values over the total concentration are useful in comparing the relative toxicity of several compounds, so they were kept in place.

NOTE: The Risk-Based Concentration (RBC) Table is updated annually. Use the latest version of the RBC Table in calculating emergency removal guidelines.

Following the list of emergency removal trigger guidelines is the list of removal numeric action levels for contaminated drinking water sites. This list was prepared by the U.S. EPA Office of Solid Waste and Emergency Response, Emergency Response Division and released in March 1995. The list reflects EPA and oral toxicity data and associated health criteria available for the listed chemicals. The toxicity data has been obtained from EPA's Integrated Risk Information System (IRIS), and EPA's Health Effects Assessment Summary Tables (HEAST).

EMERGENCY REMOVAL GUIDELINES 1997 Technical Support Section Region III (3HW41) 841 Chestnut Street Philadelphia, Pennsylvania 19107	
Exposure Variables	Value
1 - General:	
Carcinogenic potency slope oral (kg-d/mg):	*
Carcinogenic potency slope inhaled (kg-d/mg):	*
Reference dose oral (mg/kg/d):	*
Reference dose inhaled (mg/kg/d):	*
Target cancer risk:	1E-04
Target hazard quotient:	10
Body weight, adult (kg):	70
Body weight, age 1 - 6 (kg):	15
Averaging time carcinogens (d):	25550
Averaging time non-carcinogens (d):	ED*365
Air inhaled, adult (m ³ /d):	20
Air inhaled, age 1 - 6 (m ³ /d):	12

EMERGENCY REMOVAL GUIDELINES 1997 Technical Support Section Region III (3HW41) 841 Chestnut Street Philadelphia, Pennsylvania 19107	
Exposure Variables	Value
Inhalation factor, age adjusted ($\text{m}^3\text{-y/kg-d}$):	11.66
Tap water ingested, adult (L/d):	2
Tap water ingested, age 1 - 6 (L/d):	1
Tap water ingestion factor, age adjusted (L-y/kg-d):	1.09
Fish ingested (g/d):	54
Soil ingested, adult (mg/d):	100
Soil ingested, age 1 - 6 (mg/d):	200
Soil ingestion factor, age adjusted (mg-y/kg-d):	114.29
2 - Residential:	
Exposure frequency (d/y):	350
Exposure duration, (total)(y):	30
Exposure duration, age 1 - 6 (y):	6
Volatilization factor (L/m^3):	0.5
3 - Occupational:	
Exposure frequency (d/y):	250
Exposure duration (y):	25
Fraction of contaminated soil ingested (unitless):	0.5
* = Contaminant-specific toxicity parameters	

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Acephate	770 C	72 C	36 C	66000 C	7300 C
Acetaldehyde	94 N	81 C	0	0	0
Acetochlor	730 N	730 N	270 N	410000 N	16000 N
Acetone	3700 N	3700 N	1400 N	2000000 N	78000 N
Acetone cyanohydrin	2600 N	1500 N	950 N	1400000 N	55000 N
Acetonitrile	220 N	520 N	81 N	120000 N	4700 N
Acetophenone	0.042 N	0.21 N	1400 N	1000000 N	78000 N
Acifluorfen	470 N	470 N	180 N	270000 N	10000 N
Acrolein	730 N	0.21 N	270 N	410000 N	16000 N
Acrylamide	1.5 C	0.14 C	0.07 C	130 C	14 C
Acrylic acid	18000 N	10 N	6800 N	1000000 N	390000 N
Acrylonitrile	12 C	2.6 C	0.58 C	1100 C	120 C
Alachlor	84 C	7.8 C	3.9 C	7200 C	800 C
Alar	5500 N	5500 N	2000 N	1000000 N	120000 N
Aldicarb	37 N	37 N	14 N	20000 N	780 N
Aldicarb sulfone	37 N	37 N	14 N	20000 N	780 N
Aldrin	0.4 C	0.037 C	0.019 C	34 C	3.8 C
Allyl	9100 N	9100 N	3400 N	1000000 N	200000 N
Allyl alcohol	180 N	180 N	68 N	100000 N	3900 N
Allyl chloride	1800 N	10 N	680 N	1000000 N	39000 N
Aluminum	37000 N	37000 N	14000 N	1000000 N	780000 N
Aluminum phosphide	15 N	15 N	5.4 N	8200 N	310 N
Amdro	11 N	11 N	4.1 N	6100 N	230 N
Ametryn	330 N	330 N	120 N	180000 N	7000 N
m-Aminophenol	2600 N	2600 N	950 N	1000000 N	55000 N
4-Aminopyridine	0.73 N	0.73 N	0.27 N	410 N	16 N
Amitraz	91 N	91 N	34 N	51000 N	2000 N
Ammonia	1000 N	1000 N	0	0	0
Ammonium sulfate	7300 N	7300 N	2700 N	1000000 N	160000 N
Aniline	10 N	10 N	55 C	100000 C	11000 C
Antimony and compounds	15 N	15 N	5.4 N	8200 N	310 N
Antimony pentoxide	18 N	18 N	6.8 N	10000 N	390 N
Antimony potassium tartrate	33 N	33 N	12 N	18000 N	700 N
Antimony tetroxide	15 N	15 N	5.4 N	8200 N	310 N
Antimony trioxide	15 N	15 N	5.4 N	8200 N	310 N
Apollo	470 N	470 N	180 N	270000 N	10000 N
Arenite	270 C	25 C	13 C	23000 C	2600 C

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Arsenic	11 N	11 N	4.1 N	6100 N	230 N
Arsenic (as carcinogen)	4.5 C	0.041 C	0.21 C	380 C	43 C
Arsine	0.52 N	0.52 N	0	0	0
Assure	330 N	330 N	120 N	180000 N	7000 N
Asulam	1800 N	1800 N	680 N	1000000 N	39000 N
Atrazine	30 C	2.8 C	1.4 C	2600 C	290 C
Avermectin B1	15 N	15 N	5.4 N	8200 N	310 N
Azobenzene	61 C	5.8 C	2.9 C	5200 C	580 C
Barium and compounds	2600 N	5.2 N	950 N	1000000 N	55000 N
Baygon	150 N	150 N	54 N	82000 N	3100 N
Bayleton	1100 N	1100 N	410 N	610000 N	23000 N
Baythroid	910 N	910 N	340 N	510000 N	20000 N
Benefin	11000 N	11000 N	4100 N	1000000 N	230000 N
Benomyl	1800 N	1800 N	680 N	1000000 N	39000 N
Bentazon	91 N	91 N	34 N	51000 N	2000 N
Benzaldehyde	610 N	3700 N	1400 N	1000000 N	78000 N
Benzene	36 C	22 C	11 C	20000 C	2200 C
Benzenethiol	0.37 N	0.37 N	0.14 N	200 N	7.8 N
Benzidine	0.029 C	0.0027 C	0.0014 C	2.5 C	0.28 C
Benzoic acid	150000 N	150000 N	54000 N	1000000 N	1000000 N
Benzotrifluoride	0.52 C	0.048 C	0.024 C	44 C	4.9 C
Benzyl alcohol	11000 N	11000 N	4100 N	1000000 N	230000 N
Benzyl chloride	6.2 C	3.7 C	1.9 C	3400 C	380 C
Beryllium and compounds	1.6 C	0.075 C	0.073 C	130 C	15 C
Bidrin	3.7 N	3.7 N	1.4 N	2000 N	78 N
Biphenrin (Talstar)	550 N	550 N	200 N	310000 N	12000 N
1,1-Biphenyl	1800 N	1800 N	680 N	1000000 N	39000 N
Bis(2-chloroethyl)ether	0.92 C	0.54 C	0.29 C	520 C	58 C
Bis(2-chloroisopropyl)ether	26 C	18 C	4.5 C	8200 C	910 C
Bis(chloromethyl)ether	0.0049 C	0.0029 C	0.0014 C	2.6 C	0.29 C
Bis(2-chloro-1-methylethyl)ether	96 C	8.9 C	4.5 C	8200 C	910 C
Bis(2-ethylhexyl)phthalate (DEHP)	480 C	45 C	23 C	41000 C	4600 C
Bisphenol A	1800 N	1800 N	680 N	1000000 N	39000 N
Boron (and borates)	3300 N	210 N	1200 N	1000000 N	70000 N
Boron trifluoride	7.3 N	7.3 N	0	0	0
Bromodichloromethane	17 C	10 C	5.1 C	9200 C	1000 C
Bromoethane	9.6 C	5.7 C	0	0	0

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Bromoform (tribromomethane)	240 C	160 C	40 C	72000 C	8100 C
Bromomethane	8.7 N	52 N	19 N	29000 N	1100 N
4-Bromophenyl phenyl ether	2100 N	2100 N	780 N	1000000 N	45000 N
Bromophos	180 N	180 N	68 N	100000 N	3900 N
Bromoxynil	730 N	730 N	270 N	410000 N	16000 N
Bromoxynil octanoate	730 N	730 N	270 N	410000 N	16000 N
1,3-Butadiene	1.1 C	0.64 C	0	0	0
1-Butanol	3700 N	3700 N	1400 N	1000000 N	78000 N
Butyl benzyl phthalate	7300 N	7300 N	2700 N	1000000 N	160000 N
Butylate	1800 N	1800 N	680 N	1000000 N	39000 N
sec-Butylbenzene	61 N	370 N	140 N	200000 N	7800 N
tert-Butylbenzene	61 N	370 N	140 N	200000 N	7800 N
Butylphthalyl butylglycolate	37000 N	37000 N	14000 N	1000000 N	780000 N
Cacodylic acid	110 N	110 N	41 N	61000 N	2300 N
Cadmium and compounds	18 N	0.099 C	6.8 N	10000 N	390 N
Caprolactam	18000 N	18000 N	6800 N	1000000 N	390000 N
Captafol	780 C	73 C	37 C	67000 C	74 C
Captan	1900 C	180 C	90 C	160000 C	18000 C
Carbaryl	3700 N	3700 N	1400 N	1000000 N	78000 N
Carbofuran	180 N	180 N	68 N	100000 N	3900 N
Carbon disulfide	1000 N	7300 N	1400 N	1000000 N	78000 N
Carbon tetrachloride	16 C	12 C	2.4 C	4400 C	490 C
Carbosulfan	370 N	370 N	140 N	200000 N	7800 N
Carboxin	3700 N	3700 N	1400 N	1000000 N	78000 N
Chloral	73 N	73 N	27 N	41000 N	1600 N
Chloramben	550 N	550 N	200 N	310000 N	12000 N
Chloranil	17 C	1.6 C	0.78 C	1400 C	160 C
Chlordane	5.2 C	0.49 C	0.24 C	440 C	49 C
Chlorimuron-ethyl	730 N	730 N	270 N	410000 N	16000 N
Chlorine	3700 N	3700 N	1400 N	1000000 N	78000 N
Chlorine dioxide	2.1 N	2.1 N	0	0	0
Chloroacetaldehyde	250 N	250 N	93 N	140000 N	5400 N
Chloroacetic acid	73 N	73 N	27 N	41000 N	1600 N
2-Chloroacetophenone	0.31 N	0.31 N	0	0	0
4-Chloroaniline	150 N	150 N	54 N	82000 N	3100 N
Chlorobenzene	39 N	210 N	270 N	410000 N	16000 N
Chlorobenzilate	25 C	2.3 C	1.2 C	2100 C	240 C

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
				mg/kg	mg/kg
p-Chlorobenzoic acid	7300 N	7300 N	2700 N	1000000 N	160000 N
4-Chlorobenzotrifluoride	730 N	730 N	270 N	410000 N	16000 N
2-Chloro-1,3-butadiene	14 N	73 N	270 N	410000 N	16000 N
1-Chlorobutane	2400 N	15000 N	5400 N	1000000 N	310000 N
Chlorodibromomethane	13 C	7.5 C	3.8 C	6800 C	760 C
1-Chloro-1,1-difluoroethane	87000 N	520000 N	0	0	0
Chlorodifluoromethane	87000 N	520000 N	0	0	0
Chloroethane	8600 N	100000 N	5400 N	1000000 N	310000 N
2-Chloroethyl vinyl ether	150 N	910 N	340 N	510000 N	20000 N
Chloroform	15 C	7.8 C	52 C	94000 C	7800 N
Chloromethane	140 C	99 C	24 C	44000 C	4900 C
4-Chloro-2,2-methylaniline hydrochloride	15 C	1.4 C	0.69 C	1200 C	140 C
4-Chloro-2-methylaniline	12 C	1.1 C	0.54 C	990 C	110 C
beta-Chloronaphthalene	2900 N	2900 N	1100 N	1000000 N	63000 N
o-Chloronitrobenzene	42 C	25 C	13 C	23000 C	2600 C
p-Chloronitrobenzene	59 C	35 C	18 C	32000 C	3500 C
2-Chlorophenol	180 N	180 N	68 N	100000 N	3900 N
2-Chloropropane	170 N	1000 N	0	0	0
Chlorothalonil	610 C	57 C	29 C	52000 C	5800 C
o-Chlorotoluene	120 N	730 N	270 N	410000 N	16000 N
Chlorpropham	7300 N	7300 N	2700 N	1000000 N	160000 N
Chlorpyrifos	110 N	110 N	41 N	61000 N	2300 N
Chlorpyrifos-methyl	370 N	370 N	140 N	200000 N	7800 N
Chlorsulfuron	1800 N	1800 N	680 N	1000000 N	39000 N
Chlorthiophos	29 N	29 N	11 N	16000 N	630 N
Chromium III and compounds	37000 N	0.021 N	14000 N	1000000 N	780000 N
Chromium VI and compounds	180 N	0.015 C	68 N	100000 N	3900 N
Coal tar	0	0.28 C	0	0	0
Cobalt	2200 N	2200 N	810 N	1000000 N	47000 N
Coke Oven Emissions	0	0.29 C	0	0	0
Copper and compounds	1500 N	1500 N	540 N	820000 N	31000 N
Crotonaldehyde	3.5 C	0.33 C	0.17 C	300 C	34 C
Cumene	1500 N	94 N	540 N	820000 N	31000 N
Cyanides:	0	0	0	0	0
Barium cyanide	3700 N	3700 N	1400 N	1000000 N	78000 N
Calcium cyanide	1500 N	1500 N	540 N	820000 N	31000 N
**Chlorine cyanide	1800 N	1800 N	680 N	1000000 N	39000 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m ³	mg/kg	mg/kg	mg/kg
Copper cyanide	180 N	180 N	68 N	100000 N	3900 N
Cyanazine	8 C	0.75 C	0.38 C	680 C	76 C
Cyanogen	1500 N	1500 N	540 N	820000 N	31000 N
Cyanogen bromide	3300 N	3300 N	1200 N	1000000 N	70000 N
Cyanogen chloride	1800 N	1800 N	680 N	1000000 N	39000 N
Free cyanide	730 N	730 N	270 N	410000 N	16000 N
Hydrogen cyanide	730 N	31 N	270 N	410000 N	16000 N
Potassium cyanide	1800 N	1800 N	680 N	1000000 N	39000 N
Potassium silver cyanide	7300 N	7300 N	2700 N	1000000 N	160000 N
Silver cyanide	3700 N	3700 N	1400 N	1000000 N	78000 N
Sodium cyanide	1500 N	1500 N	540 N	820000 N	31000 N
Thiocyanate	730 N	730 N	270 N	410000 N	16000 N
Zinc cyanide	1800 N	1800 N	680 N	1000000 N	39000 N
Cyclohexanone	30000 N	180000 N	68000 N	1000000 N	1000000 N
Cyclohexylamine	7300 N	7300 N	2700 N	1000000 N	160000 N
Cyhalothrin/Karate	180 N	180 N	68 N	100000 N	3900 N
Cypermethrin	370 N	370 N	140 N	200000 N	7800 N
Cyromazine	270 N	270 N	100 N	150000 N	5800 N
Dacthal	370 N	370 N	140 N	200000 N	7800 N
Dalapon	1100 N	1100 N	410 N	610000 N	23000 N
Danitol	910 N	910 N	340 N	510000 N	20000 N
DDD	28 C	2.8 C	1.3 C	2400 C	270 C
DDE	20 C	1.8 C	0.93 C	1700 C	190 C
DDT	20 C	1.8 C	0.93 C	1700 C	190 C
Decabromodiphenyl ether	61 N	370 N	140 N	200000 N	7800 N
Demeton	1.5 N	1.5 N	0.54 N	820 N	31 N
Diallate	17 C	10 C	5.2 C	9400 C	1000 C
Diazinon	33 N	33 N	12 N	18000 N	700 N
Dibenzofuran	150 N	150 N	54 N	82000 N	3100 N
1,4-Dibromobenzene	61 N	370 N	140 N	200000 N	7800 N
1,2-Dibromo-3-chloropropane	4.8 C	2.1 N	0.23 C	410 C	46 C
1,2-Dibromoethane	0.075 C	0.81 C	0.0037 C	6.7 C	0.75 C
Dibutyl phthalate	3700 N	3700 N	1400 N	1000000 N	78000 N
Dicamba	1100 N	1100 N	410 N	610000 N	23000 N
1,2-Dichlorobenzene	270 N	1500 N	1200 N	1000000 N	70000 N
1,3-Dichlorobenzene	540 N	3200 N	1200 N	1000000 N	70000 N
1,4-Dichlorobenzene	44 C	26 C	13 C	24000 C	2700 C

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commerical	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
3,3'-Dichlorobenzidine	15 C	1.4 C	0.7 C	1300 C	140 C
1,4-Dichloro-2-butene	0.11 C	0.067 C	0	0	0
Dichlorodifluoromethane	390 N	2100 N	2700 N	1000000 N	160000 N
1,1-Dichloroethane	810 N	5200 N	1400 N	1000000 N	78000 N
1,2-Dichloroethane (EDC)	12 C	8.9 C	3.5 C	6300 C	700 C
1,1-Dichloroethylene	4.4 C	3.6 C	0.53 C	950 C	110 C
1,2-Dichloroethylene (cis)	61 N	370 N	140 N	200000 N	7800 N
1,2-Dichloroethylene (trans)	120 N	730 N	270 N	410000 N	16000 N
1,2-Dichloroethylene (mixture)	55 N	330 N	120 N	180000 N	7000 N
2,4-Dichlorophenol	110 N	110 N	41 N	61000 N	2300 N
2,4-Dichlorophenoxyacetic Acid (2,4-D)	61 N	370 N	140 N	200000 N	7800 N
4-(2,4-Dichlorophenoxy)butyric Acid	290 N	290 N	110 N	160000 N	6300 N
1,2-Dichloropropane	18 C	8.2 C	4.6 C	8400 C	940 C
2,3-Dichloropropanol	110 N	110 N	41 N	61000 N	2300 N
1,3-Dichloropropane	7.7 C	4.8 C	1.8 C	3300 C	230 N
Dichlorvos	23 C	2.2 C	1.1 C	2000 C	220 C
Dicofol	15 C	1.4 C	0.72 C	1300 C	150 C
Dicyclopentadiene	0.42 N	2.1 N	410 N	610000 N	23000 N
Dieldrin	0.42 C	0.039 C	0.02 C	36 C	4 C
Diesel emissions	52 N	52 N	0	0	0
Diethyl phthalate	29000 N	29000 N	11000 N	1000000 N	630000 N
Diethylene glycol, monobutyl ether	210 N	210 N	0	0	0
Diethylene glycol, monoethyl ether	73000 N	73000 N	27000 N	1000000 N	1000000 N
Diethylformamide	400 N	400 N	150 N	220000 N	8600 N
Di(2-ethylhexyl)adipate	5600 C	520 C	260 C	480000 C	53000 C
Diethylstilbestrol	0.0014 C	0.00013 C	0.000067 C	0.12 C	0.014 C
Difenzoquat (Avange)	2900 N	2900 N	1100 N	1000000 N	63000 N
Diflubenzuron	730 N	730 N	270 N	410000 N	16000 N
1,1-Difluoroethane	69000 N	420000 N	0	0	0
Diisopropyl methylphosphonate (DIMP)	2900 N	2900 N	1100 N	1000000 N	63000 N
Dimethipin	730 N	730 N	270 N	410000 N	16000 N
Dimethoate	7.3 N	7.3 N	2.7 N	4100 N	160 N
3,3'-Dimethoxybenzidine	480 C	45 C	23 C	41000 C	4600 C
Dimethylamine	0.21 N	0.21 N	0	0	0
2,4-Dimethylaniline hydrochloride	12 C	1.1 C	0.54 C	990 C	110 C
2,4-Dimethylaniline	9 C	0.83 C	0.42 C	760 C	85 C
N-N-Dimethylaniline	73 N	73 N	27 N	41000 N	1600 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
3,3'-Dimethylbenzidine	0.73 C	0.068 C	0.034 C	62 C	6.9 C
N,N-Dimethylformamide	3700 N	310 N	1400 N	1000000 N	78000 N
1,1-Dimethylhydrazine	2.6 C	0.18 C	0.12 C	220 C	25 C
1,2-Dimethylhydrazine	0.18 C	0.017 C	0.0085 C	15 C	1.7 C
2,4-Dimethylphenol	730 N	730 N	270 N	410000 N	16000 N
2,6-Dimethylphenol	22 N	22 N	8.1 N	12000 N	470 N
3,4-Dimethylphenol	37 N	37 N	14 N	20000 N	780 N
Dimethyl phthalate	370000 N	370000 N	140000 N	1000000 N	1000000 N
Dimethyl terephthalate	3700 N	3700 N	1400 N	1000000 N	78000 N
1,2-Dinitrobenzene	15 N	15 N	5.4 N	8200 N	310 N
1,3-Dinitrobenzene	3.7 N	3.7 N	1.4 N	2000 N	78 N
1,4-Dinitrobenzene	15 N	15 N	5.4 N	8200 N	310 N
4,6-Dinitro-o-cyclohexyl phenol	73 N	73 N	27 N	41000 N	1600 N
2,4-Dinitrophenol	73 N	73 N	27 N	41000 N	1600 N
Dinitrotoluene mixture	9.9 C	0.92 C	0.46 C	840 C	94 C
2,4-Dinitrotoluene	73 N	73 N	27 N	41000 N	1600 N
2,6-Dinitrotoluene	37 N	37 N	14 N	20000 N	780 N
Dinoseb	37 N	37 N	14 N	20000 N	780 N
di-n-Octyl phthalate	730 N	730 N	270 N	410000 N	16000 N
1,4-Dioxane	610 C	57 C	29 C	52000 C	5800 C
Diphenamid	1100 N	1100 N	410 N	610000 N	23000 N
Diphenylamine	910 N	910 N	340 N	510000 N	20000 N
1,2-Diphenylhydrazine	8.4 C	0.81 C	0.39 C	720 C	80 C
Diquat	80 N	80 N	30 N	45000 N	1700 N
Direct black 38	0.78 C	0.073 C	0.037 C	67 C	7.4 C
Direct blue 6	0.83 C	0.077 C	0.039 C	71 C	7.9 C
Direct brown 95	0.72 C	0.067 C	0.034 C	62 C	6.9 C
Disulfoton	1.5 N	1.5 N	0.54 N	820 N	31 N
1,4-Dithiane	370 N	370 N	140 N	200000 N	7800 N
Diuron	73 N	73 N	27 N	41000 N	1600 N
Dodine	150 N	150 N	54 N	82000 N	3100 N
Endosulfan	220 N	220 N	81 N	120000 N	4700 N
Endothall	730 N	730 N	270 N	410000 N	16000 N
Endrin	11 N	11 N	4.1 N	6100 N	230 N
Epichlorohydrin	680 C	10 N	32 C	58000 C	6500 C
1,2-Epoxybutane	210 N	210 N	0	0	0
Ethephon (2-chloroethyl phosphonic acid)	180 N	180 N	68 N	100000 N	3900 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commerical	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Ethion	18 N	18 N	6.8 N	10000 N	390 N
2-Ethoxyethanol acetate	11000 N	11000 N	4100 N	1000000 N	230000 N
2-Ethoxyethanol	15000 N	2100 N	5400 N	1000000 N	310000 N
Ethyl acrylate	140 C	13 C	6.6 C	12000 C	1300 C
EPTC (S-Ethyl dipropylthiocarbamate)	910 N	910 N	340 N	510000 N	20000 N
Ethyl acetate	33000 N	33000 N	12000 N	1000000 N	700000 N
Ethylbenzene	1300 N	10000 N	1400 N	1000000 N	78000 N
Ethylene cyanohydrin	11000 N	11000 N	4100 N	1000000 N	230000 N
Ethylene diamine	730 N	730 N	270 N	410000 N	16000 N
Ethylene glycol	73000 N	73000 N	27000 N	1000000 N	1000000 N
Ethylene glycol, monobutyl ether	210 N	210 N	0	0	0
Ethylene oxide	6.6 C	1.8 C	0.31 C	580 C	63 C
Ethylene thiourea (ETU)	57 C	5.3 C	2.7 C	4800 C	540 C
Ethyl ether	1200 N	7300 N	2700 N	1000000 N	160000 N
Ethyl methacrylate	3300 N	3300 N	1200 N	1000000 N	70000 N
Ethyl p-nitrophenyl phenylphosphorothioate	0.37 N	0.37 N	0.14 N	200 N	7.8 N
Ethyl nitrosourea	0.048 C	0.0045 C	0.0023 C	4.1 C	0.46 C
Ethylphthalyl ethyl glycolate	110000 N	110000 N	41000 N	1000000 N	1000000 N
Express	290 N	290 N	110 N	160000 N	6300 N
Fenamiphos	9.1 N	9.1 N	3.4 N	5100 N	200 N
Fluometuron	470 N	470 N	180 N	270000 N	10000 N
Fluoride	2200 N	2200 N	810 N	1000000 N	47000 N
Fluoridone	2900 N	2900 N	1100 N	1000000 N	63000 N
Flurprimidol	730 N	730 N	270 N	410000 N	16000 N
Flutolanil	2200 N	2200 N	810 N	1000000 N	47000 N
Fluvalinate	370 N	370 N	140 N	200000 N	7800 N
Folpet	1900 C	180 C	90 C	160000 C	18000 C
Fomesafen	35 C	3.3 C	1.7 C	3000 C	340 C
Fonofos	73 N	73 N	27 N	41000 N	1600 N
Formaldehyde	7300 N	14 C	2700 N	1000000 N	160000 N
Formic Acid	73000 N	73000 N	27000 N	1000000 N	1000000 N
Fosetyl-al	110000 N	110000 N	41000 N	1000000 N	1000000 N
Furan	37 N	37 N	14 N	20000 N	780 N
Furazolidone	1.8 C	0.16 C	0.083 C	150 C	17 C
Furfural	110 N	520 N	41 N	61000 N	2300 N
Furium	0.13 C	0.013 C	0.0063 C	11 C	1.3 C
Furmecyclox	220 C	21 C	11 C	19000 C	2100 C

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Glufosinate-ammonium	15 N	15 N	5.4 N	8200 N	310 N
Glycidaldehyde	15 N	10 N	5.4 N	8200 N	310 N
Glyphosate	3700 N	3700 N	1400 N	1000000 N	78000 N
Haloxypol-methyl	1.8 N	1.8 N	0.68 N	1000 N	39 N
Harmony	470 N	470 N	180 N	270000 N	10000 N
HCH (alpha)	1.1 C	0.099 C	0.05 C	91 C	10 C
HCH (beta)	3.7 C	0.35 C	0.18 C	320 C	35 C
HCH (gamma) Lindane	5.2 C	0.48 C	0.24 C	440 C	49 C
HCH-technical	3.7 C	0.35 C	0.18 C	320 C	35 C
Heptachlor	0.23 C	0.14 C	0.07 C	130 C	14 C
Heptachlor epoxide	0.12 C	0.069 C	0.035 C	63 C	7 C
Hexabromobenzene	12 N	73 N	27 N	41000 N	1800 N
Hexachlorobenzene	0.66 C	0.39 C	0.2 C	360 C	40 C
Hexachlorobutadiene	14 C	8.1 C	4.0 C	7300 C	820 C
Hexachlorocyclopentadiene	0.15 N	0.73 N	95 N	140000 N	5500 N
Hexachlorodibenzo-p-dioxin mixture	0.0011 C	0.00014 C	0.000051 C	0.092 C	0.01 C
Hexachloroethane	75 C	45 C	23 C	410000 C	4600 C
Hexachlorophene	11 N	11 N	4.1 N	6100 N	230 N
Hexahydro-1,3,5-trinitro-1,3,5-triazine	61 C	5.7 C	2.9 C	5200 C	580 C
1,6-Hexamethylene diisocyanate	0.1 N	0.1 N	0	0	0
n-Hexane	350 N	2100 N	810 N	1000000 N	47000 N
Hexazinone	1200 N	1200 N	450 N	670000 N	26000 N
Hydrazine, hydrazine sulfate	2.2 C	0.037 C	0.11 C	190 C	21 C
Hydrogen chloride	210 N	210 N	0	0	0
Hydrogen sulfide	110 N	10 N	41 N	61000 N	2300 N
Hydroquinone	1500 N	1500 N	540 N	820000 N	31000 N
Imazalil	470 N	470 N	180 N	270000 N	10000 N
Imazaquin	9100 N	9100 N	3400 N	1000000 N	200000 N
Iprodione	1500 N	1500 N	540 N	820000 N	31000 N
Iron	11000 N	11000 N	4100 N	1000000 N	230000 N
Isobutanol	1800 N	11000 N	4100 N	1000000 N	230000 N
Isophorone	7100 C	660 C	330 C	600000 C	67000 C
Isopropalin	550 N	550 N	200 N	310000 N	12000 N
Isopropyl methyl phosphonic acid	3700 N	3700 N	1400 N	1000000 N	78000 N
Isoxaben	1800 N	1800 N	680 N	1000000 N	39000 N
Kepone	0.37 C	0.035 C	0.018 C	32 C	3.5 C
Lactofen	73 N	73 N	27 N	41000 N	1600 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Linuron	73 N	73 N	27 N	41000 N	1600 N
Lithium	730 N	730 N	270 N	410000 N	16000 N
Londax	7300 N	7300 N	2700 N	1000000 N	160000 N
Malathion	730 N	730 N	270 N	410000 N	16000 N
Maleic anhydride	3700 N	3700 N	1400 N	1000000 N	78000 N
Maleic hydrazide	18000 N	18000 N	6800 N	1000000 N	390000 N
Malononitrile	0.73 N	0.73 N	0.27 N	410 N	16 N
Mancozeb	1100 N	1100 N	410 N	610000 N	23000 N
Maneb	180 N	180 N	68 N	100000 N	3900 N
**Manganese and compounds	8.10 N	0.52 N	310 N	470000 N	18000 N
Maprofosolan	3.3 N	3.3 N	1.2 N	1800 N	70 N
Mapiquat chloride	1100 N	1100 N	410 N	610000 N	23000 N
Mercuric chloride	11 N	11 N	4.1 N	6100 N	230 N
Mercury (inorganic)	11 N	3.1 N	4.1 N	6100 N	230 N
Mercury (methyl)	3.7 N	3.7 N	1.4 N	2000 N	78 N
Mephos	1.1 N	1.1 N	0.41 N	610 N	23 N
Mephos oxide	1.1 N	1.1 N	0.41 N	610 N	23 N
Metolaxyl	2200 N	2200 N	810 N	1000000 N	47000 N
Methacrylonitrile	3.7 N	7.3 N	1.4 N	2000 N	78 N
Methamidophos	1.8 N	1.8 N	0.68 N	1000 N	39 N
Methanol	18000 N	18000 N	6800 N	1000000 N	390000 N
Methidathion	37 N	37 N	14 N	20000 N	780 N
Methomyl	910 N	910 N	340 N	510000 N	20000 N
Methoxychlor	180 N	180 N	68 N	100000 N	3900 N
2-Methoxyethanol acetate	73 N	73 N	27 N	41000 N	1600 N
2-Methoxyethanol	37 N	210 N	14 N	20000 N	780 N
2-Methoxy-5-nitroaniline	150 C	14 C	6.9 C	12000 C	1400 C
Methyl acetate	37000 N	37000 N	14000 N	1000000 N	780000 N
Methyl acrylate	1100 N	1100 N	410 N	610000 N	23000 N
2-Methylaniline hydrochloride	37 C	3.5 C	1.8 C	3200 C	350 C
2-Methylaniline	28 C	2.6 C	1.3 C	2400 C	270 C
Methyl chlorocarbonate	37000 N	37000 N	14000 N	1000000 N	780000 N
4-(2-Methyl-4-chlorophenoxy) butyric acid	370 N	370 N	140 N	200000 N	7800 N
2-Methyl-4-chlorophenoxyacetic acid	18 N	18 N	6.8 N	10000 N	390 N
2-(2-Methyl-14-chlorophenoxy)propionic acid	37 N	37 N	14 N	20000 N	780 N
Methylcyclohexane	31000 N	31000 N	0	0	0
Methylene bromide	61 N	370 N	140 N	200000 N	7800 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Methylene chloride	410 C	380 C	42 C	76000 C	8500 C
4,4'-Methylene bis(2-chloroaniline)	52 C	4.8 C	2.4 C	4400 C	490 C
4,4'-Methylenedibenzeneamine	27 C	2.5 C	1.3 C	2300 C	260 C
4,4'-Methylene bis(N,N'-dimethylaniline)	150 C	14 C	6.9 C	12000 C	1400 C
4,4'-Methylenediphenyl isocyanate	0.035 N	0.21 N	0	0	0
Methyl ethyl ketone	1900 N	10000 N	8100 N	1000000 N	470000 N
Methyl hydrazine	6.1 C	0.57 C	0.29 C	520 C	58 C
Methyl isobutyl ketone	2900 N	840 N	1100 N	1000000 N	63000 N
Methyl methacrylate	2900 N	2900 N	1100 N	1000000 N	63000 N
2-Methyl-5-nitroaniline	200 C	19 C	9.6 C	17000 C	1900 C
Methyl parathion	9.1 N	9.1 N	3.4 N	5100 N	200 N
2-Methylphenol (o-cresol)	1800 N	1800 N	680 N	1000000 N	39000 N
3-Methylphenol (m-cresol)	1800 N	1800 N	680 N	1000000 N	39000 N
4-Methylphenol (p-cresol)	180 N	180 N	68 N	100000 N	3900 N
Methyl styrene (mixture)	60 N	420 N	81 N	120000 N	4700 N
Methyl styrene (alpha)	430 N	2600 N	950 N	1000000 N	55000 N
Methyl tertbutyl ether (MTBE)	180 N	31000 N	68 N	100000 N	3900 N
Metolacolor (Dual)	5500 N	5500 N	2000 N	1000000 N	120000 N
Metribuzin	910 N	910 N	340 N	510000 N	20000 N
Mirex	3.7 C	0.35 C	0.18 C	320 C	35 C
Molinate	73 N	73 N	27 N	41000 N	1600 N
Molybdenum	180 N	180 N	68 N	100000 N	3900 N
Monochloramine	3700 N	3700 N	1400 N	1000000 N	78000 N
Naled	73 N	73 N	27 N	41000 N	1600 N
2-Naphthylamine	0.052 C	0.0048 C	0.0024 C	4.4 C	0.49 C
Napropamide	3700 N	3700 N	1400 N	1000000 N	78000 N
Nickel refinery dust	0	0.75 C	0	0	0
Nickel and compounds	730 N	730 N	270 N	410000 N	16000 N
Nickel subsulfide	0	0.37 C	0	0	0
Nitrapyrin	55 N	55 N	20 N	31000 N	1200 N
Nitrate	58000 N	58000 N	22000 N	1000000 N	1000000 N
Nitric oxide	3700 N	3700 N	1400 N	1000000 N	78000 N
Nitrite	3700 N	3700 N	1400 N	1000000 N	78000 N
2-Nitroaniline	2.2 N	2.1 N	0.81 N	1200 N	47 N
3-Nitroaniline	110 N	110 N	41 N	61000 N	2300 N
4-Nitroaniline	110 N	110 N	41 N	61000 N	2300 N
Nitrobenzene	3.4 N	21 N	6.8 N	10000 N	390 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Nitrofurantoin	2600 N	2600 N	950 N	1000000 N	55000 N
Nitrofurazone	4.5 C	0.067 C	0.21 C	380 C	43 C
Nitrogen dioxide	37000 N	37000 N	14000 N	1000000 N	780000 N
Nitroguanidine	3700 N	3700 N	1400 N	1000000 N	78000 N
4-Nitrophenol	2300 N	2300 N	840 N	1000000 N	48000 N
2-Nitropropane	210 N	0.067 C	0	0	0
N-Nitrosodi-n-butylamine	1.2 C	0.11 C	0.058 C	110 C	12 C
N-Nitrosodiethanolamine	2.4 C	0.22 C	0.11 C	200 C	23 C
N-Nitrosodiethylamine	0.045 C	0.0041 C	0.0021 C	3.8 C	0.43 C
N-Nitrosodimethylamine	0.13 C	0.013 C	0.0082 C	11 C	1.3 C
N-Nitrosodiphenylamine	1400 C	130 C	64 C	120000 C	13000 C
N-Nitroso di-n-propylamine	0.96 C	0.089 C	0.045 C	82 C	9.1 C
N-Nitroso-N-methylethylamine	0.31 C	0.028 C	0.014 C	26 C	2.9 C
N-Nitrosopyrrolidine	3.2 C	0.29 C	0.15 C	270 C	30 C
m-Nitrotoluene	61 N	370 N	140 N	200000 N	7800 N
o-Nitrotoluene	61 N	370 N	140 N	200000 N	7800 N
p-Nitrotoluene	61 N	370 N	140 N	200000 N	7800 N
Norflurazon	1500 N	1500 N	540 N	820000 N	31000 N
NuStar	26 N	26 N	9.5 N	14000 N	550 N
Octabromodiphenyl ether	110 N	110 N	41 N	61000 N	2300 N
Octahydro-1357-tetranitro-1357-tetrazocine	1800 N	1800 N	680 N	1000000 N	39000 N
Octamethylpyrophosphoramide	73 N	73 N	27 N	41000 N	1600 N
Oryzalin	1800 N	1800 N	680 N	1000000 N	39000 N
Oxadiazon	180 N	180 N	68 N	100000 N	3900 N
Oxamyl	910 N	910 N	340 N	510000 N	20000 N
Oxyfluorfen	110 N	110 N	41 N	61000 N	2300 N
Paclobutrazol	470 N	470 N	180 N	270000 N	10000 N
Paraquat	160 N	160 N	61 N	92000 N	3500 N
Parathion	220 N	220 N	81 N	120000 N	4700 N
Pebulate	1800 N	1800 N	680 N	1000000 N	39000 N
Pendimethalin	1500 N	1500 N	540 N	820000 N	31000 N
Pentabromo-6-chloro cyclohexane	290 C	27 C	14 C	25000 C	2800 C
Pentabromodiphenyl ether	73 N	73 N	27 N	41000 N	1600 N
Pentachlorobenzene	4.9 N	29 N	11 N	16000 N	630 N
Pentachloronitrobenzene	4.1 C	2.4 C	1.2 C	2200 C	250 C
Pentachlorophenol	56 C	5.2 C	2.6 C	4800 C	530 C
Permethrin	1800 N	1800 N	680 N	1000000 N	39000 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Phenmedipham	9100 N	9100 N	3400 N	1000000 N	200000 N
Phenol	22000 N	22000 N	8100 N	1000000 N	470000 N
m-Phenylenediamine	220 N	220 N	81 N	120000 N	4700 N
p-Phenylenediamine	6900 N	6900 N	2600 N	1000000 N	150000 N
Phenylmercuric acetate	2.9 N	2.9 N	1.1 N	1600 N	63 N
2-Phenylphenol	3500 C	320 C	160 C	300000 C	33000 C
Phorate	7.3 N	7.3 N	2.7 N	4100 N	160 N
Phosmet	730 N	730 N	270 N	410000 N	16000 N
Phosphine	11 N	3.1 N	4.1 N	6100 N	230 N
Phosphoric acid	100 N	100 N	0	0	0
Phosphorus (white)	0.73 N	0.73 N	0.27 N	410 N	16 N
p-Phthalic acid	37000 N	37000 N	14000 N	1000000 N	780000 N
Phthalic anhydride	73000 N	1300 N	27000 N	1000000 N	1000000 N
Picloram	2600 N	2600 N	950 N	1000000 N	55000 N
Phosphor-methyl	370 N	370 N	140 N	200000 N	7800 N
Polybrominated biphenyls	0.76 C	0.07 C	0.035 C	64 C	5.5 N
Polychlorinated biphenyls (PCBs)	3.35 C	0.313 C	0.160 C	286 C	31.9 C
Aroclor 1016	2.6 N	2.6 N	0.95 N	1400 N	55 N
Aroclor 1254	0.73 N	0.73 N	0.27 N	410 N	16 N
Polychlorinated terphenyls (PCTs)	1.5 C	0.14 C	0.07 C	130 C	14 C
Polynuclear aromatic hydrocarbons	0	0	0	0	0
Acenaphthene	2200 N	2200 N	810 N	1000000 N	47000 N
Anthracene	11000 N	11000 N	4100 N	1000000 N	230000 N
Benz[a]anthracene	9.2 C	1 C	0.43 C	780 C	88 C
Benzo[b]fluoranthene	9.2 C	1 C	0.43 C	780 C	88 C
Benzo[k]fluoranthene	92 C	10 C	4.3 C	7800 C	870 C
Benzo[a]pyrene	0.92 C	0.1 C	0.043 C	78 C	8.8 C
Carbazole	340 C	31 C	16 C	29000 C	3200 C
Chrysene	920 C	100 C	43 C	78000 C	8700 C
Dibenz[ah]anthracene	0.92 C	0.1 C	0.043 C	78 C	8.8 C
Fluoranthene	1500 N	1500 N	540 N	820000 N	31000 N
Fluorene	1500 N	1500 N	540 N	820000 N	31000 N
Indeno[1,2,3-cd]pyrene	9.2 C	1 C	0.43 C	780 C	88 C
Naphthalene	1500 N	1500 N	540 N	820000 N	31000 N
Pyrene	1100 N	1100 N	410 N	810000 N	23000 N
Prochloraz	45 C	4.2 C	2.1 C	3800 C	430 C
Profuralin	220 N	220 N	81 N	120000 N	4700 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Prometon	550 N	550 N	200 N	310000 N	12000 N
Prometryn	150 N	150 N	54 N	82000 N	3100 N
Pronamide	2700 N	2700 N	1000 N	1000000 N	59000 N
Propachlor	470 N	470 N	180 N	270000 N	10000 N
Propanil	180 N	180 N	68 N	100000 N	3900 N
Propargite	730 N	730 N	270 N	410000 N	16000 N
Propargyl alcohol	73 N	73 N	27 N	41000 N	1600 N
Propazine	730 N	730 N	270 N	410000 N	16000 N
Propham	730 N	730 N	270 N	410000 N	16000 N
Propiconazole	470 N	470 N	180 N	270000 N	10000 N
Propylene glycol	730000 N	730000 N	270000 N	1000000 N	1000000 N
Propylene glycol, monoethyl ether	26000 N	26000 N	9500 N	1000000 N	550000 N
Propylene glycol, monomethyl ether	26000 N	21000 N	9500 N	1000000 N	550000 N
Propylene oxide	28 C	49 C	1.3 C	2400 C	270 C
Pursuit	9100 N	9100 N	3400 N	1000000 N	200000 N
Pydin	910 N	910 N	340 N	510000 N	20000 N
Pyridine	37 N	37 N	14 N	20000 N	780 N
Quinalphos	18 N	18 N	6.8 N	10000 N	390 N
Quinoline	0.56 C	0.052 C	0.026 C	48 C	5.3 C
Resmethrin	1100 N	1100 N	410 N	610000 N	23000 N
Ronnel	1800 N	1800 N	680 N	1000000 N	39000 N
Rotenone	150 N	150 N	54 N	82000 N	3100 N
Savay	910 N	910 N	340 N	510000 N	20000 N
Selenious Acid	180 N	180 N	68 N	100000 N	3900 N
Selenium	180 N	180 N	68 N	100000 N	3900 N
Selenourea	180 N	180 N	68 N	100000 N	3900 N
Sethoxydim	3300 N	3300 N	1200 N	1000000 N	70000 N
Silver and compounds	180 N	180 N	68 N	100000 N	3900 N
Simazine	56 C	5.2 C	2.6 C	4800 C	530 C
Sodium azide	150 N	150 N	54 N	82000 N	3100 N
Sodium diethyldithiocarbamate	25 C	2.3 C	1.2 C	2100 C	240 C
Sodium fluoroacetate	0.73 N	0.73 N	0.27 N	410 N	16 N
Sodium metavanadate	37 N	37 N	14 N	20000 N	780 N
Strontium, stable	22000 N	22000 N	8100 N	1000000 N	470000 N
Strychnine	11 N	11 N	4.1 N	6100 N	230 N
Styrene	1600 N	10000 N	2700 N	1000000 N	160000 N
Systhane	910 N	910 N	340 N	510000 N	20000 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
2,3,7,8-TCDD (dioxin)	0.000043 C	0.0000054 C	0.000002 C	0.0037 C	0.00041 C
Tebuthiuron	2600 N	2600 N	950 N	1000000 N	55000 N
Temaphos	730 N	730 N	270 N	410000 N	16000 N
Terbacil	470 N	470 N	180 N	270000 N	10000 N
Terbufos	0.91 N	0.91 N	0.34 N	510 N	20 N
Terbutryn	37 N	37 N	14 N	20000 N	760 N
1,2,4,5-Tetrachlorobenzene	1.8 N	11 N	4.1 N	6100 N	230 N
1,1,1,2-Tetrachloroethane	41 C	24 C	12 C	22000 C	2500 C
1,1,2,2-Tetrachloroethane	5.2 C	3.1 C	1.6 C	2900 C	320 C
Tetrachloroethylene (PCE)	110 C	310 C	6.1 C	11000 C	1200 C
2,3,4,6-Tetrachlorophenol	1100 N	1100 N	410 N	610000 N	23000 N
p,p',d,d'-Tetrachlorotoluene	0.053 C	0.031 C	0.016 C	29 C	3.2 C
Tetrachlorovinphos	280 C	28 C	13 C	24000 C	2700 C
Tetraethylthiopyrophosphate	18 N	18 N	6.8 N	10000 N	390 N
Tetraethyl lead	0.0037 N	0.0037 N	0.0014 N	2 N	0.078 N
1,1,1,2-Tetrafluoroethane	140000 N	840000 N	0	0	0
Thallic oxide	2.6 N	2.6 N	0.95 N	1400 N	55 N
Thallium	0	0	0	0	0
Thallium acetate	3.3 N	3.3 N	1.2 N	1800 N	70 N
Thallium carbonate	2.9 N	2.9 N	1.1 N	1600 N	63 N
Thallium chloride	2.9 N	2.9 N	1.1 N	1600 N	63 N
Thallium nitrate	3.3 N	3.3 N	1.2 N	1800 N	70 N
Thallium selenite	3.3 N	3.3 N	1.2 N	1800 N	70 N
Thallium sulfate	2.9 N	2.9 N	1.1 N	1600 N	63 N
Thiobencarb	370 N	370 N	140 N	200000 N	7800 N
2-(Thiocyanomethylthio)-benzothiazole	1100 N	1100 N	410 N	610000 N	23000 N
Thiofanox	11 N	11 N	4.1 N	6100 N	230 N
Thiophanate-methyl	2900 N	2900 N	1100 N	1000000 N	63000 N
Thiram	180 N	180 N	68 N	100000 N	3900 N
Tin and compounds	22000 N	22000 N	8100 N	1000000 N	470000 N
Toluene	750 N	4200 N	2700 N	1000000 N	160000 N
Toluene-2,4-diamine	2.1 C	0.2 C	0.099 C	180 C	20 C
Toluene-2,5-diamine	22000 N	22000 N	8100 N	1000000 N	470000 N
Toluene-2,6-diamine	7300 N	7300 N	2700 N	1000000 N	160000 N
p-Toluidine	35 C	3.3 C	1.7 C	3000 C	340 C
Toxaphene	6.1 C	0.56 C	0.29 C	520 C	58 C
Tralomethrin	270 N	270 N	100 N	150000 N	5900 N

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water ug/L	Ambient Air ug/m3	Fish mg/kg	Soil	
				Industrial/ Commercial mg/kg	Residential mg/kg
Triallate	470 N	470 N	180 N	270000 N	10000 N
Trisulfuron	370 N	370 N	140 N	200000 N	7800 N
1,2,4-Tribromobenzene	30 N	180 N	68 N	100000 N	3900 N
Tributyltin oxide (TBTO)	1.1 N	1.1 N	0.41 N	610 N	23 N
2,4,6-Trichloroaniline hydrochloride	230 C	22 C	11 C	20000 C	2200 C
2,4,6-Trichloroaniline	200 C	18 C	9.3 C	17000 C	1900 C
1,2,4-Trichlorobenzene	190 N	2100 N	140 N	200000 N	7800 N
*1,1,1-Trichloroethane	790 N	10000 N	470 N	720000 N	27000 N
1,1,2-Trichloroethane	19 C	11 C	5.5 C	10000 C	1100 C
Trichloroethylene (TCE)	160 C	100 C	29 C	52000 C	4700 N
Trichlorofluoromethane	1300 N	7300 N	4100 N	1000000 N	230000 N
2,4,5-Trichlorophenol	3700 N	3700 N	1400 N	1000000 N	78000 N
2,4,6-Trichlorophenol	610 C	57 C	29 C	52000 C	5800 C
2,4,5-Trichlorophenoxyacetic acid	370 N	370 N	140 N	200000 N	7800 N
2-(2,4,5-Trichlorophenoxy)propionic acid	290 N	290 N	110 N	180000 N	6300 N
1,1,2-Trichloropropane	30 N	180 N	68 N	100000 N	3900 N
1,2,3-Trichloropropane	0.15 C	0.089 C	0.045 C	82 C	9.1 C
1,2,3-Trichloropropane	30 N	180 N	68 N	100000 N	3900 N
1,1,2-Trichloro-1,2,2-trifluoroethane	59000 N	310000 N	410000 N	1000000 N	1000000 N
Tridiphenyl	110 N	110 N	41 N	61000 N	2300 N
Triethylamine	73 N	73 N	0	0	0
Trifluralin	870 C	81 C	41 C	74000 C	5900 N
1,2,4-Trimethylbenzene	300 N	1800 N	680 N	1000000 N	39000 N
1,3,5-Trimethylbenzene	300 N	1800 N	680 N	1000000 N	39000 N
Trimethyl phosphate	180 C	17 C	8.5 C	15000 C	1700 C
1,3,5-Trinitrobenzene	1.8 N	1.8 N	0.68 N	1000 N	39 N
Trinitrophenylmethylnitramine	370 N	370 N	140 N	200000 N	7800 N
2,4,6-Trinitrotoluene	18 N	18 N	6.8 N	10000 N	390 N
Uranium (soluble salts)	110 N	110 N	41 N	61000 N	2300 N
Vanadium	260 N	260 N	95 N	140000 N	5500 N
Vanadium pentoxide	330 N	330 N	120 N	180000 N	7000 N
Vanadium sulfate	730 N	730 N	270 N	410000 N	16000 N
Vernam	37 N	37 N	14 N	20000 N	780 N
Vinclozolin	910 N	910 N	340 N	510000 N	20000 N
Vinyl acetate	37000 N	2100 N	14000 N	1000000 N	780000 N
Vinyl bromide	5.2 N	31 N	0	0	0
Vinyl chloride	1.9 C	2.1 C	0.17 C	300 C	34 C

Contaminant	C - carcinogen		N - noncarcinogen		
	Tap Water	Ambient Air	Fish	Soil	
				Industrial/ Commercial	Residential
	ug/L	ug/m3	mg/kg	mg/kg	mg/kg
Warfarin	11 N	11 N	4.1 N	6100 N	230 N
m-Xylene	1400 N	7300 N	27000 N	1000000 N	1000000 N
o-Xylene	1400 N	7300 N	27000 N	1000000 N	1000000 N
p-Xylene	520 N	3100 N	0	0	0
Xylene (mixed)	12000 N	73000 N	27000 N	1000000 N	1000000 N
Zinc	11000 N	11000 N	4100 N	1000000 N	230000 N
Zinc phosphide	11 N	11 N	4.1 N	6100 N	230 N
Zinc	1800 N	1800 N	680 N	1000000 N	39000 N

Mr

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES (APRIL 1997)

71

Emergency Response Division
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC 20460

Table Acronyms

CAS #	Chemical Abstract Number
DWEL	Drinking Water Equivalent Level; calculated by multiplying the oral RfD by 70 kilograms (adult body weight) and dividing by the average volume of water (2 liters) consumed per day
Longer-term HA (Child)	Drinking Water Health Advisory for 10 kilogram child consuming 1 liter of water per day for up to 7 years
MCL	Maximum Contaminant Level (National Primary Drinking Water Standard)
MCLG	Maximum Contaminant Level Goal
MFL	Million Fibers per Liter
treat	MCL is based on the capability of the treatment technology
URTH-STAR	Short-term Risk Level (STAR) recommended for an Unreasonable Risk to Health (URTH) under the Safe Drinking Water Act (SWDA)

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)

72

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Acenaphthene	83329	-	-	2,100	-	-	-	2,100
Acetone	67641	D	-	3,500*	-	-	-	3,500
Acifluorfen (Tackle)	62476599	B2	100	400	100	-/0	-	100
Acrylamide (2-Propenamide)	79061	B2	1	7	20	treat/0	1	1
Acrylonitrile	107131	B1	6	-	-	-/0	-	6
Adipates (Diethylhexyl)	103231	C	3,000	20,000	20,000	400/400	-	4,000
Alachlor	15972608	B2	40	400	-	2/0	40	40
Aldicarb (Temik)	116063	D	-	35	-	7/7	-	35
Aldicarb sulfone	1646884	D	-	35	-	7/7	-	35
Aldicarb sulfoxide	-	D	-	35	-	7/7	-	35

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)

73

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	Removal Action Level (ug/L)
Aldrin	309002	B2	0.2	1	0.3	-	-	0.2
Ametyrn	834128	D	-	300	900	-	-	300
Ammonium sulfamate	7773060	D	-	8,000	20,000	-	-	8,000
Anthracene	120127	D	-	11,000	-	-	-	11,000
Atrazine	1912249	C	-	200	50	3/3	30	30
Baygon	114261	C	-	100	40	-	-	40
Bentazon	25057890	D	-	90	300	-	-/20	300
Benz(a)anthracene	56553	B2	-	-	-	0.1/0	-	-
Benzene	71432	A	100	-	-	5/0	100	100
Benzo(a)pyrene	50328	B2	-	-	-	0.2/0	-	0.2
Benzo(b)fluoranthene	205992	B2	-	-	-	0.2/0	-	-
Benzo(k)fluoranthene	207089	B2	-	-	-	0.2/0	-	-
bis-2-Chloroisopropyl ether	108601	D	-	1,000	4,000	-	-	1,000
Bromacil	314409	C	-	5,000	3,000	-	-	3,000
Bromochloromethane	74975	D*	-	500	1,000	-	-	50

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

74

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Bromodichloromethane	75274	B2	60	700	4,000	100/(80 ^b)/0	-	100
Bromoform	75252	B2	400	700	2,000	100/(80 ^b)/0	-	400
Bromomethane (Methyl bromide)	74839	D	-	40	100	-	-	50
Butanone (2-) (see Methyl ethyl ketone)								
Butyl benzyl phthalate	85687	C	-	6,000	-	100/0	-	7,000
Butylate	2008415	D	-	2,000	1,000	-	-	1,000
Carbaryl	63252	D	-	4,000	1,000	-	-	1,000
Carbofuran	1563662	E	-	200	50	40/40	50	50
Carbon tetrachloride	56235	B2	30	30	70	5/0	30	30
Carboxin	5234684	D	-	4,000	1,000	-	-	1,000
Chloral hydrate (Trichloroacetaldehyde monohydrate)	302170	C	-	60	200	60 ^c /40	-	60
Chloramben	133904	D	-	500	200	-	-	200

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)

75

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	Removal Action Level (ug/L)
Chlordane	57749	B2	3	2	-	2/0	2	2
Chlorobenzene (see Monochlorobenzene)								
Chlorodibromomethane (Dibromo-chloromethane)	124481	C	-	700	2,000	100/(80 ^b)/60	-	600
Chloroform (Trichloromethane)	67663	B2	600	400	100	100/(80 ^b)/0	-	100
Chloromethane (Methyl chloride)	74873	C	-	100	400	-	-	100
Chlorophenol (2-)	95578	D	-	200	50	-	-	200
Chlorothalonil	1897456	B2	150	500	200	-	-	150
Chlorotoluene, o-	95498	D	-	700	2,000	-	-	700
Chlorotoluene, p-	106434	D	-	700	2,000	-	-	700
Chlorpyrifos	2921882	D	-	100	30	-	-	30
Chrysene	218019	B2	-	-	-	0.2/0	-	-
Cumene (see Isopropylbenzene)								
Cyanazine	21725462	C	-	70	20	-/1	-	10

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

76

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
2,4-D(2,4-Dichlorophenoxyacetic acid)	94757	D	-	400	100	70/70	100	100
Dacthal (DCPA)	1861321	D	-	20,000	5,000	-	-	400
Dalapon	75990	D	-	900	300	200/200	-	300
Di[2-ethylhexyl]adipate	103231	C	3,000	20,000	20,000	400/400	-	4,000
Diazinon	333415	E	-	3	5	-	-	3
Dibenzo[a,h]anthracene	53703	B2	-	-	-	0.3/0	-	-
Dibromoacetonitrile	3252435	C	-	800	2,000	-	-	800
Dibromochloromethane (see Chlorodi- bromomethane)								
Dibromochloropropane (DBCP)	96128	B2	3	-	-	0.2/0	3	3
Dibromomethane (Methylene bromide)	74953	D	-	-	-	-	-	-
Dibutyl phthalate (di-n-Butyl phthalate)	84742	D	-	4,000	-	-	-	4,000
Dicamba	1918009	D	-	1,000	300	-	-	300
Dichloroacetic acid	79436	B2	-	100	1,000	60/0	-	100

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)

77

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Dichloroacetonitrile	3018120	C	-	300	800	-	-	300
Dichlorobenzene -o (1,2-)	95501	D	-	3,000	9,000	600/600	3,000	3,000
Dichlorobenzene -m (1,3-)	541731	D	-	3,000	9,000	600/600	-	3,000
Dichlorobenzene -p (1,4-)	106467	C	-	4,000	10,000	75/75	750	750
Dichlorodifluoromethane (Freon-12)	75718	D	-	5,000	9,000	-	-	5,000
Dichloroethane (1,1-)	75343	C ^a	-	3,500 ^a	-	-	-	-
Dichloroethane (1,2-) (Ethylene dichloride)	107062	B2	40	-	700	5/0	40	40
Dichloroethylene (1,1-)	75354	C	-	400	1,000	7/7	70	70
Dichloroethylene (cis- 1,2-)	156592	D	-	400	3,000	70/70	400	400
Dichloroethylene (trans- 1,2-)	156605	D	-	600	2,000	100/100	600	600
Dichloromethane (Methylene chloride)	75092	B2	500	2,000	-	5/0	-	500
Dichlorophenol (2,4-)	120832	D	-	100	30	-	-	30
Dichloropropane (1,2-)	78875	B2 ^a	-	-	-	5/0	-	60

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)

78

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Dichloropropene(1,3-)(cis and trans)	542756	B2	20	10	30	-/0	-	10
Dieldrin	60571	B2	0.2	2	0.50	-	-	0.2
Diethyl phthalate	84662	D	-	30,000	-	-	-	30,000
Diethylhexyl (see Adipates)								
Diethylhexyl phthalate	117817	B2	300	700	-	6/0	-	300
Dimethrin	70382	D	-	10,000	10,000	-	-	10,000
Dimethyl methylphosphonate	756796	C	700	7,000	2,000	-	-	2,000
Dimethyl phthalate	131113	D	-	-	-	-	-	-
DIMP (Diisopropyl methyl phosphonate)	1445756	D	-	3,000	8,000	-	-	3,000
Dinitrobenzene (1,3-)	99650	D	-	5	40	-	-	5
Dinitrotoluene (2,4-)	121142	-	-	100	300	-	-	5
Dinitrotoluene (2,6-)	25321146	-	-	40	400	-	-	5
Dinitrotoluene, tg ⁴ (2,6-&2,4-)	-	B2	5	-	-	-	-	5
Dinoseb	88857	D	-	40	10	7/7	-	10
Dioxane p- (1,4-)	123911	B2	700	-	-	-	-	700

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

79

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH-STAR-Level (ug/L)	Removal Action Level (ug/L)
Dioxin (see 2,3,7,8-TCDD)							-	
Diphenamid	957517	D	-	1,000	300	-	-	300
Diphenylamine	122394	D	-	1,000	300	-	-	300
Diquat	85007	D	-	80	-	20/20	-	80
Disulfoton	298044	E	-	1	3	-	-	1
Dithiane (1,4-)	505293	D	-	400	400	-	-	400
Diuron	330541	D	-	70	300	-	-	70
Endothall	145733	D	-	700	200	100/100	-	200
Endrin	72208	D	-	10	3	2/2	-	3
Epichlorohydrin	106898	B2	400	70	70	treat/0	70	70
Ethylbenzene	100414	D	-	3,000	1,000	700/700	1,000	1,000
Ethylene dibromide (1,2-)(EDB)	106934	B2	0.04	-	-	0.05/0	0.05	0.05
Ethylene dichloride (see 1,2-Dichloroethane)								

REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)

80

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Ethylene glycol	107211	D	-	40,000	6,000	-	-	6,000
Ethyl ether	60297	-	-	7,000 ^a	-	-	-	7,000
Ethylene thiourea (ETU)	96457	B2	30	3	100	-	-	3
Fenamiphos	22224926	D	-	9	5	-	-	5
Fluometuron	2164172	D	-	400	2,000	-	-	400
Fluorene	86737	D	-	1,400	-	-	-	1,400
Fluorotrichloromethane (Freon-11)	75694	D	-	10,000	3,000	-	-	3,000
Fonofos	944229	D	-	70	20	-	-	20
Formaldehyde	50000	B1	-	5,000	5,000	-	-	5,000
Freon-11 (see Fluorotrichloromethane)								
Freon-12 (see Dichlorodifluoromethane)								
Freon-113 (1,1,2-Trichloro-1,2,2,-trifluoroethane)	76131	-	-	1,100,000 ^a	-	-	-	1,100,000
Glyphosate	1071836	E	-	4,000	1,000	700/700	-	1,000

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

81

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	Removal Action Level (ug/L)
Heptachlor	76448	B2	0.8	20	5	0.4/0	0.8	0.8
Heptachlor epoxide	1024573	B2	0.4	0.4	0.1	0.2/0	0.4*	0.4
Hexachlorobenzene	118741	B2	2	30	50	1/0	-	2
Hexachlorobutadiene	87683	C	-	70	100	-/1	-	10
Hexachlorocyclohexane, gamma (see Lindane)								
Hexachlorocyclopentadiene	77474	D	-	200	-	50/50	-	200
Hexachloroethane	67721	C	-	40	100	-	-	40
Hexane (n-)	110543	D	-	-	4,000	-	-	4,000
Hexazinone	51235042	D	-	1,000	3,000	-	-	1,000
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	2691410	D	-	2,000	5,000	-	-	2,000
Indeno[1,2,3-c,d]pyrene	193395	B2	-	-	-	0.4/0	-	-
Isophorone	78591	C	4,000	7,000	15,000	-	-	7,000

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

82

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Isopropyl methylphosphonate	6838933	D	-	4,000	30,000	-	-	4,000
Isopropylbenzene (Cumene)	988828	-	-	1,400*	-	-	-	1,400
Kerb (see Pronamide)								
Lindane (Hexachlorocyclohexane, gamma)	58899	C	-	10	30	0.2/0.2	2	2
Malathion	121755	D	-	800	200	-	-	200
Maleic hydrazide	123331	D	-	20,000	5,000	-	-	5,000
MCPA (4-Chloro-2-methylphenoxy)- acetic acid	94746	E	-	50	100	-	-	50
Methomyl	16752775	D	-	900	300	-	-	300
Methoxychlor	72435	D	-	200	50	40/40	50	50
Methyl bromide (see Bromomethane)								
Methyl chloride (see Chloromethane)								
Methyl ethyl ketone (2-Butanone)	78933	D*	-	21,000*	-	-	-	21,000
Methyl parathion	298000	D	-	9	30	-	-	9

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

83

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁶ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Methyl tert butyl ether	1634044	D	-	200	500	-	-	1,000
Methylene bromide (see Dibromomethane)								
Methylene chloride (see Dichloromethane)								
Metolachlor	51218452	C	-	3,500	1,000	-	-	2,000
Metribuzin	21087649	D	-	900	300	-	-	300
Monochloroacetic acid (Chloroacetic acid)	79118	-	-	70*	-	-	-	70
Monochlorobenzene (Chlorobenzene)	108907	D	-	700	2,000	100/100	700	700
Naphthalene	91203	D	-	100	400	-	-	100
Nitroguanidine	556887	D	-	4,000	10,000	-	-	4,000
Nitrophenols p-	25154556	D	-	300	800	-	-	300
Octachlorocamphene (see Toxaphene)								
Oxyamyl	23135220	E	-	900	200	200/200	-	200
Paraquat	1910425	E	-	200	50	-	-	50
Pentachloronitrobenzene (PCNB)	82688	C*	-	100*	-	-	-	20
Pentachlorophenol	87865	B2	30	1,000	300	1/0	30	30

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

84

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA Child (ug/L)	MCL/ MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Perchloroethylene (see Tetrachloroethylene)								
Phenol	108952	D	-	20,000	6,000	-	-	6,000
Picloram	1918021	D	-	2,000	700	500/500	-	700
Polychlorinated biphenyls (PCBs)	1336363	B2	0.5	-	-	0.5/0	0.5	0.5
Prometon	1610180	D	-	500	200	-	-	200
Pronamide (Kerb)	23950585	C	-	3,000	800	-	-	800
Propachlor	1918167	D	-	500	100	-	-	100
Propazine	139402	C	-	700	500	-	-	500
Propham	122429	D	-	600	5,000	-	-	600
Pyrene	129000	D	-	1,100	-	-	-	1,100
RDX (Hexahydro-1,3,5-trinitro- 1,3,5-triazine)	121824	C	30	100	100	-	-	100
Simazine	122349	C	-	200	70	4/4	-	40

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

85

Chemical ORGANICS	CAS#	Cancer Risk		Standards and Health Advisories				Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA Child (ug/L)	MCL/MCLG (ug/L)	URTH-STAR-Level (ug/L)	Removal Action Level (ug/L)
Styrene	100425	C	-	7,000	2,000	100/100	1,000	1,000
T (2,4,5-)	93765	D	-	350	800	-	-	350
Tackle (see Acifluorfen)		-						
TCDD (2,3,7,8-) (v) (Dioxin)	1746016	B2	0.00002	0.00004	0.00001	0.00003/0	-	0.00003
Tebuthiuron	34014181	D	-	2,000	700	-	-	700
Temik (see Aldicarb)								
Terbacil	5902512	E	-	400	300	-	-	300
Terbufos	13071799	D	-	5	1	-	-	1
Tetrachloroethane (1,1,1,2-)	630206	C	100	1,000	900	-	-	900
Tetrachloroethane (1,1,2,2-)	79345	C*	20*	-	-	-	-	20
Tetrachloroethylene (Perchloro-ethylene)	127184	B2*	70	500	1,000	5/0	70	70
Toluene	108883	D	-	7,000	2,000	1,000/1,000	-	2,000
Toxaphene (Octachlorocamphene)	8001352	B2	3	3	-	3/0	3	3

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

88

Chemical INORGANICS	CAS#	Standards and Health Advisories						Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA (Child) (ug/L)	MCL/MCLG (ug/L)	URTH-STAR-Level (ug/L)	Removal Action Level (ug/L)
Ammonia	7664417	D	-	-	-	-	-	34,000 ^a (taste)
Antimony	7440360	D	-	10	10	6/6	-	10
Arsenic	7440382	A	2	-	-	50/-	-	50
Asbestos Fibers > 10 um	1332214	A	700 MFL	-	-	7MFL/7MFL	70MFL	70MFL ^b
Barium	7440393	D	-	2,000	-	2,000/2,000	-	2,000
Beryllium	7440417	B2	0.8	200	4,000	4/4	-	4
Boron	7440428	D	-	3,000	900	-	-	900
Bromate	15541454	-	-	-	-	10/0	-	10
Cadmium	7440439	D	-	20	5	5/5	5	5
Chloramines (measured free chlorine)	10599903	D ^a	-	3,300	1,000	4,000/4,000	-	4,000
Chlorine	7782505	D	-	3,500	-	4,000/4,000	-	4,000

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

89

Chemical INORGANICS	CAS#	Standards and Health Advisories						Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA (Child) (ug/L)	MCL/MCLG (ug/L)	URTH- STAR- Level (ug/L)	
Chlorine dioxide	10049044	D	-	350	-	800/300	-	800
Chlorite	77558192	D	-	100	-	1,000/80	-	1,000
Chromium III (see Chromium, total)	16065831							
Chromium VI (see Chromium, total)	18540299							
Chromium, total	-	D	-	200	200	100/100	200	200
Copper	7440508	D	-	-	-	treat/1,300	1,300	1,300
Cyanide	57125	D	-	800	200	200/200	-	200
Fluoride	16984488	-	-	4,200	-	4,000/4,000	5,000 ^c	5,000
Hypochlorite	7681529	-	-	-	-	-/4,000	-	-
Hypochlorous acid	7790923	-	-	-	-	1/4,000	-	-
Lead at tap	7439921	B2	-	-	-	treat/0	30 ^c	30
Manganese	7439965	D ^a	-	200	-	-/-	-	-

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

90

Chemical INORGANICS	CAS#			Standards and Health Advisories				Superfund
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer-term HA (Child) (ug/L)	MCL/MCLG (ug/L)	URTH-STAR-Level (ug/L)	Removal Action Level (ug/L)
Mercury	7439976	D	-	10	-	2/2	10	10
Molybdenum	7439987	D	-	200	10	-	-	10
Nickel	7440020	D	-	600	500	100/100	-	500
Nitrate	14797558	-	-	56,000	-	10,000/10,000	10,000	10,000
Nitrite	14797650	-	-	5,600	-	1,000/1,000	1,000	1,000
Nitrate + Nitrite	-	-	-	-	-	10,000/10,000	10,000	10,000
Selenium	7782492	-	-	200	-	50/50	200	200
Silver	7440224	D	-	200	200	-	-	100 ^d
Strontium	7440246	D	-	90,000	25,000	-	-	25,000
Sulfate	7757826	-	-	-	-	-	-	250,000 aesthetics
Thallium	7440280	-	-	2	7	2/0.5	-	2

**REMOVAL NUMERIC ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
(APRIL 1997)**

91

Chemical INORGANICS	CAS#	Standards and Health Advisories						Superfund Removal Action Level (ug/L)
		Cancer Group	10 ⁻⁴ Cancer Risk (ug/L)	DWEL (ug/L)	Longer- term HA (Child) (ug/L)	MCL/MCLG (ug/L)	URTH -STAR- Level (ug/L)	
Vanadium	7440622	D	-	250 ^a	-	-	-	250
White phosphorus	772314	D	-	0.5	-	-	-	0.5
Zinc	7440666	D	-	10,000	3,000	-	-	3,000
Zinc chloride (measured as Zinc)	-	D	-	10,000	3,000	-	-	3,000

^a Based on data from IRIS or HEAST in the absence of a published U.S. EPA, Office of Water value

^b MFL = million fibers per liter

^c Based on special considerations

^d Secondary Maximum Contamination Level intended to protect general public from argyria (a cosmetic effect) over a lifetime

APPENDIX 1

Toxicology

Exposure to hazardous chemicals may produce a wide range of adverse health effects. The likelihood of an adverse health effect occurring, and the severity of the effect, are dependent on the toxicity of the chemical, route of exposure, and the nature and extent of exposure to dose from that substance. In order to better understand potential health effects, emergency personnel should have an understanding of the basic principles and terminology of toxicology.

Toxicology is the study of the adverse effects of chemicals on living organisms.

Types of Toxic Hazards

1. Systemic poisons - Systemic poisons are chemical agents which act on specific target organs or organ systems. Systemic poisons are divided into the following categories:

- Anesthetics/narcotics (e.g. ethyl ether).
- Compounds damaging liver function (e.g. carbon tetrachloride and tetrachloroethane).
- Compounds damaging kidney function (e.g. halogenated hydrocarbons such as chloroform).

- Compounds damaging the nervous system (e.g. ethanol, carbon disulfide, and organophosphates).
- Compounds damaging blood/circulatory system (e.g. benzene and phenols).

2. Asphyxiants - Asphyxiants are agents which deprive the tissues of oxygen. This group is divided into simple or chemical asphyxiants and both simple and chemical asphyxiants.

- The simple asphyxiants act by diluting or displacing atmospheric oxygen, which lowers the concentration of oxygen in air. Breathing air with a low oxygen concentration causes insufficient oxygen in the blood and tissues. This can cause headache, loss of consciousness, and eventually death. Examples of simple asphyxiants are aliphatic hydrocarbons, nitrogen, hydrogen, and methane.
- Chemical asphyxiants act in one of two ways:
 - The first type of chemical asphyxiant prevents the uptake of oxygen in the blood. For example, carbon monoxide interferes with the transport of oxygen to the tissues by strongly binding with hemoglobin to form carboxy hemoglobin which leaves inadequate hemoglobin available for oxygen transport.
 - The second type of chemical asphyxiant does not permit normal oxygen transfer from the blood to the tissues or within the cell itself. Hydrogen cyanide is an example of this type.
- Some compounds can act as both simple and chemical asphyxiants. Hydrogen sulfide, which is extremely toxic, is an example.

An important aspect of asphyxia and respiratory toxicants is the effect of oxygen-deficient atmospheres. Normal

content in air ranges from 19.5 percent to 23.5 percent. Some atmospheres, such as those generated during a fire or hazardous material release, contain less oxygen. For this reason, it is imperative that the oxygen content of any atmosphere be determined before the selection of respiratory protective equipment. Confined space entries represent an especially hazardous exposure situation. Particular attention should be paid to the presence of combustible or explosive atmospheres, as volatile organic vapors can collect rapidly within a confined space. Attention should also be paid to low-lying areas, where vapors heavier than air can collect.

EFFECTS OF OXYGEN CONCENTRATION ON HUMANS

PERCENT OXYGEN	EFFECTS
>23.5	Explosive atmosphere, keep out!
21-16	Nothing abnormal
16-12	Loss of peripheral vision Rapid breathing and heart rate Impaired coordination
12-10	Poor judgement and coordination Excessive fatigue Permanent heart damage Sparse breathing
10-6	Nausea Loss of movement Unconsciousness followed by death
Less than 6	Spasmodic breathing Convulsive movements Death

3. Irritants - Irritants are materials that cause inflammation of tissues. The mechanism of irritation is by either corrosive or drying action and may affect the eyes, skin, respiratory membranes or gastrointestinal tract. The irritant must come in direct contact with tissue to cause an inflammation reaction. Consequently, skin, eye, and respiratory irritants are the greatest concern for response personnel.

- Examples of skin irritants are acids, alkalies, solvents, and detergents.
- Examples of respiratory irritants are ozone, ammonia, hydrogen chloride, and nitrogen dioxide.

4. Pneumoconiosis - Pneumoconiosis is the reaction of the tissues due to accumulation of dust in the lungs. Chronic inhalation of mineral dust such as silica and asbestos can result in pneumoconiosis.

5. Allergic sensitizers - Sensitizers affect the immune system of the exposed person, causing a delayed hypersensitivity to the sensitizing agent. The allergic reaction shows one or more symptoms, which can range from discomfort from poison ivy to a fatal reaction from isocyanates.

- Examples of skin sensitizers are poison ivy and formaldehyde.
- Examples of respiratory sensitizers are sulfur dioxide and isocyanate.

6. Mutagens - A mutagen is any substance that affects genetic material in the lab or in a live animal. Thousands of mutagens have been identified through the use of tests like the Ames Salmonella Assay. Mutagenesis is not a symptom or a disease, but a mechanism by which diseases may develop.

- Examples of mutagens are ionizing radiation, benzene and hydrogen peroxide.

7. Carcinogens - Carcinogens cause cancer in lab animals or in humans.

- Examples of carcinogens are poly bis-chloromethyl ether, polynuclear aromatics, and 13-napthylamine.

8. Teratogens - Teratogens cause damage to the unborn children of the exposed person by a number of mechanisms. Maternal alcohol abuse throughout pregnancy is the most important single cause of drug-induced teratogenesis. Another example of a teratogen is thalidomide.

9. Biological agents - Categories of biological agents include:

- viruses, such as HIV (which causes AIDS)
- bacteria, such as *Streptococcus*
- fungi, such as yeasts and ringworm
- parasites, such as *Entamoeba histolytica*
- rickettsia, such as *Rickettsia rickettsi*

Routes of Exposure

The route by which personnel are exposed to a compound plays a role in determining the total amount of the compound taken up by the body because a compound may be absorbed following exposure by one route more readily than by another. In addition to the route of exposure, the amount of the compound absorbed by the body depends on the duration of exposure to the compound and the concentration of the compound to which one is exposed. Therefore, a complex relationship exists between the total amount of the compound absorbed by the body (dose) and the concentration of that compound in the environment. This relationship is important for emergency response personnel to understand because the adverse effects produced by a toxic compound are often related to the dose of that compound received by the person. However, because we usually only monitor the concentration of the toxic substance in the environment (e.g., parts per million (ppm) of a compound in air), the actual dose of the compound received by the person is seldom known. Factors specific to the

exposed person, such as size of the skin surface area exposed, presence of an open wound or breaks in the skin, and rate and depth of respiration, are important in estimating the dose of the compound received by the person.

There are only four pathways for substances to enter the body:

- contact with skin, eye, and hair
- inhalation
- ingestion
- injection

Inhalation

Inhalation of toxic agents generally results in a rapid and effective absorption of the compounds into the blood stream because of the large surface area of the lung tissue and number of blood vessels in the lungs.

The toxic effects of particulates depend on the physical and chemical properties of the particles in question and on the particle size. Larger particles settle in the upper portions of the system to be removed by ciliary action. The smaller the particle, however, the greater ability it has to travel deep into the small spaces of the lung, thus potentially causing greater harm. Once small particles are deposited in the lower portions of the lungs, their fate includes:

- Absorption into the bloodstream (particles of greater than 5.0 micrometers do not normally diffuse through cell walls).
- Removal through phagocytosis, a process in which immune cells attempt to remove the particles by incorporating them into their cell structure.
- Cell toxicity resulting in fibrotic (scar-like) tissue formation and decreased gas exchange area.

Certain types of particulates, such as asbestos and silica, can not be effectively eliminated by the body. Incomplete removal results in

irritation and death of the cell, causing further immune response. Irritation may be severe enough to cause fibrosis of portions of the lung or a cancerous growth.

Absorption

Absorption of toxic agents as a route of exposure refers to the passage of toxicants through either the skin, eyes, or other openings in the body. Absorption is the second most common route of exposure to hazardous materials, and frequently occurs through direct contact between the chemical and the skin of the exposed person.

The skin serves as a barrier to prevent most foreign substances from entering the body. It also functions to preserve the components of the body. The skin has three layers: 1) the epidermis, the outermost layer, is composed of mostly dead cells that adhere to the living tissue underneath and is responsible for the skin's effectiveness as a barrier; 2) the dermis, a layer of loose connective tissue, contains the blood vessels closest to the skin surface and is actively involved in wound repair; and 3) the hypodermis, the innermost layer, contains connective and adipose (fat) tissue.

The absorption of chemicals through the skin is called percutaneous absorption. It depends upon:

- The integrity of the skin.
- The vehicle through which the toxicant is administered.
- The type of toxicant.

Factors that facilitate percutaneous absorption include:

- Reduced integrity of the outer skin layer.
- Increased hydration of the skin.
- Increased temperature of the skin.
- Altered skin pH.
- Increased blood flow to the skin.
- Increased concentration of the toxicant.
- Decreased particle size of the toxicant.
- Electrically induced movement of the toxicant.
- The addition of agents that react with the skin surface.

Skin contact does not typically result in as rapid of a systemic dosage as inhalation, although some chemicals are readily absorbed through the skin. Many organic compounds are lipid (fat) soluble and can therefore be rapidly absorbed through the skin.

The same chemicals that can damage the skin can damage the eye. The eyes are actually more sensitive to exposure than the skin due to their high fluid content and lack of a barrier. The primary concerns with exposure to ocular toxicants are:

- Local effects - direct effects caused by the application of a chemical to the cornea.
- Systemic effects - effects to other organs or organ systems in the body, caused by the application of a chemical to the eye.
- Ocular side effects - effects which occur in the eye from exposure to toxicants through other routes of exposure such as inhalation and ingestion.

The types of chemicals noted for their ocular toxicity are acids, bases, organic solvents, detergents, and lacrimators. Acids affect the eye by reacting with protein in the tissues and by dehydrating the tissues. Treatment involves flushing the eye with large amounts of water. Generally, the greater the concentration of the acid, the greater ability it has to induce harm.

Alkaline substances (bases) act on the eye in a very different manner than acidic ones. Bases produce the same initial effects as acids, due to the pH of the base and the heat produced during reaction. However, contrary to acid burns, the effects observed immediately after exposure to an alkaline substance are not a good indication of the total effects of exposure because latent effects may continue to occur up to two weeks after exposure. An example of the impact of an alkaline substance on the eye is exposure to sodium hydroxide (NaOH); irrigation of the eye with a concentrated solution of NaOH for more than three minutes could cause catastrophic changes in the cornea leading to complete opacification (clouding) within a week to ten days after exposure. Other alkaline substances that are potent ocular toxicants include potassium hydroxide and ammonia.

Organic solvents react with the proteins and fats in the eye, causing severe pain. Damage is usually not extensive and can be reversed. In the case of heated solvents, there is the threat of burning, resulting in damage that is often severe and unpredictable. Examples of organic solvents include ethanol, toluene, and acetone.

Detergents react to lower the surface tension of the liquids in the eye, causing pronounced irritation followed by extensive tearing. Concentrated doses can cause severe burns with permanent fogging of the cornea. Examples of detergents include household cleaning agents, emulsifying agents, wetting agents, and antifoaming agents.

Lacrimators are chemical compounds or mixtures which have the ability to induce instant tearing at very low concentrations without reacting with the tissues of the eye. High concentrations can cause tissue damage. Examples include mace (tear gas) and smog.

Ingestion

The ingestion of hazardous substances is the third most frequent route of exposure in humans. Ingestion of hazardous substances occurs through the consumption of:

- Contaminated waters.
- Fish from contaminated waters.
- Contaminated plants and animals.
- Incidental ingestion of soils and dusts.

Exposure to toxicants through ingestion is of most concern with young children who can ingest large amounts of soil every day in the course of normal play activities. Young children are also particularly susceptible to the adverse effects of some contaminants (lead, for example) that may be ingested.

Once a toxicant is ingested, it enters the gastrointestinal (GI) tract. The GI tract is essentially a long tube beginning at the lips and ending at the anus, and includes the mouth, esophagus, stomach, and small and large intestine. Throughout the course of the GI tract, ingested toxicants can be absorbed into the bloodstream. Absorption primarily occurs in three main areas of the GI tract: the stomach, the small intestine, and the large intestine.

The human liver has sophisticated mechanisms for the detoxification of foreign substances. These mechanisms include enzymatic reactions and excretion to the bile and urine. Liver functions can, however, convert a substance into an even more toxic form. In addition, detoxification mechanisms are easily overridden, particularly in cases of exposure to multiple agents or to large doses of a single agent.

Exposure to toxic chemicals through the GI tract can result in both local and systemic effects. Local effects include the reaction of the chemical with the exposed internal surface of the GI tract, as in the case of burns from acid ingestion. Systemic effects result from absorption of the chemical into the bloodstream and transport to critical organs.

Ingestion is a less common route of exposure for emergency personnel at hazardous material incidents, although incidental hand to mouth contact, smoking and swallowing saliva and mucus containing trapped airborne contaminants can cause exposure by this route. Even so, toxicity by mouth is of a lower order because the gastrointestinal lining resists the transport of most toxic agents.

Injection

Injection refers to the combination of toxic exposure with a physical trauma, such as a laceration. This route of exposure, although less common than the others, should be considered very dangerous, since the toxicant is being directly injected into the bloodstream of the exposed person. Proper site safety practices (e.g., the buddy system) can be effective in preventing injection exposures.

Some significant exposures have occurred by injection. Animal bites fall into this category.

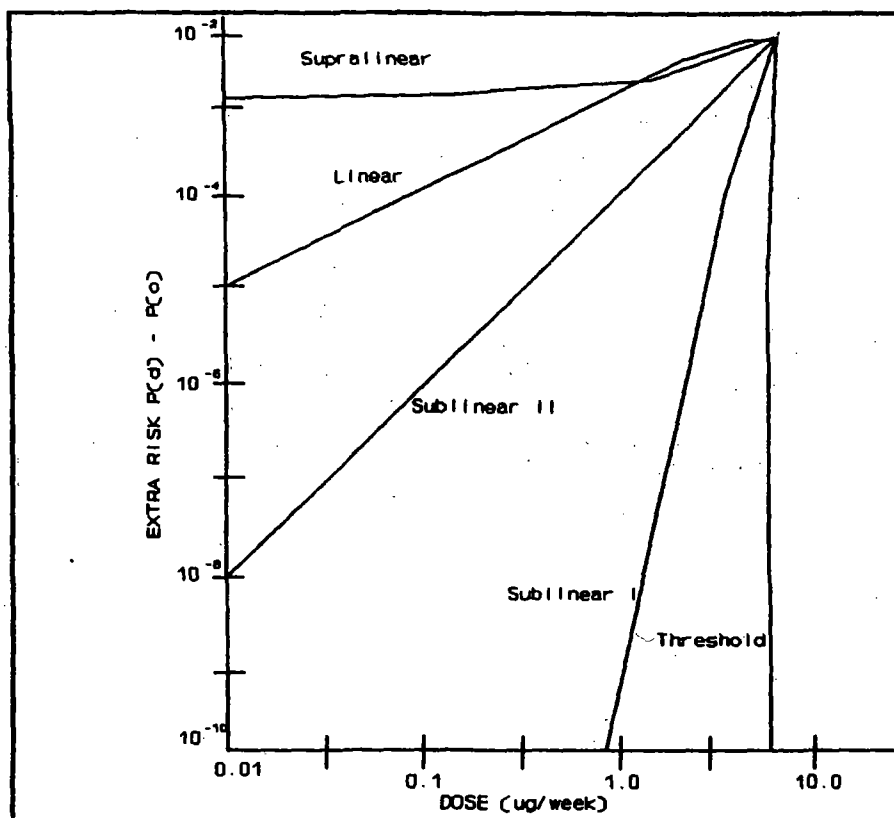
Biological Variation

Biological variation is the term used for the occurrence of differing susceptibilities in a population exposed to a toxic chemical. Factors that contribute to biological variation include sex, age, nutritional status, weight, metabolic type, and state of health. Biological variation is accounted for in all models of toxicological testing.

Dose-Response Relationship

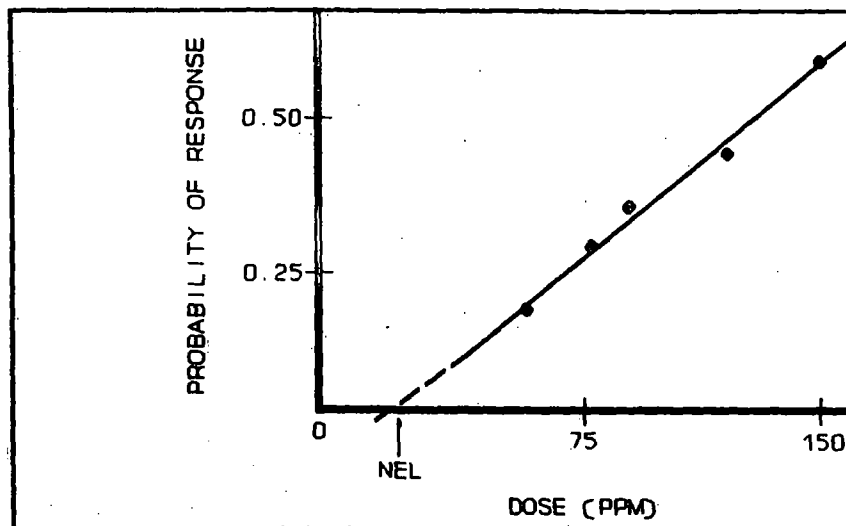
The effect produced by a toxic compound is a function of the dose of the compound received by the organism. This principle, termed the dose-response relationship, is a key concept in toxicology. Typically, as the dose increases, the severity of the toxic response increases.

1. The carcinogens - Carcinogenesis does not have a threshold. Thus, there can never be a zero response (or risk); even the smallest dose will result in some finite risk. It should be noted that the most conservative model is the linear (or one-hit) model. This is the most conservative, because the model predicts a given response (or risk) at the lowest allowable level of exposure.



Results of alternative extrapolation models for the same experimental data. NOTE: Dose-response functions were developed (Crump, in press) for data from a benzopyrene carcinogenesis experiment with mice conducted by Lee and O'Neill (1971).

2. Non-carcinogens - A dose response curve is sought from the literature for the most sensitive biological system in an experimental animal model.



No effect level (NEL): NEL is the dose which will produce no effect in the most sensitive biological system for which data can be found. To add an additional measure of safety for extrapolation to humans, this NEL is further divided by a safety factor of 100 to yield an allowable level of exposure for humans. If other data, either animal or human epidemiologic, suggest a lower level of concern for the compound under review, then the NEL may be divided by 10. Conversely, if other data suggests a higher level of concern, then the NEL may be divided by 1,000. This approach of a threshold "no effect level," coupled with the use of a safety factor ranging from 10 to 1,000 has served the FDA, the food industry and the American public.

Exposure to Chemical Mixture

Emergency health threat determinations involving mixtures are complex and difficult to make because little is known about the toxic properties of a mixture of compounds. Chemicals in a mixture can interact with each other and with the body to produce any one of the four following effects:

- **Additive Effects** (e.g., $2+3+4=9$). These effects are produced when the combined effect of the chemicals is equal to the sum of the individual effects of all the chemicals in the mixture. Examples of a mixture that produces additive effects are organophosphate pesticides such as parathion and malathion.
- **Synergistic Effects** (e.g., $2+3+4=27$). Effects that are greater than the sum of the component chemicals in the mixture are said to be synergistic effects. An example of a synergistic effect is the combined effects of cigarette smoke and asbestos; smokers show a strikingly higher cancer rate from asbestos exposure than do nonsmokers.
- **Potentiation Effects** (e.g., $0+2=10$). One of the chemicals in a mixture may not itself be particularly toxic, but it reacts to increase the toxicity of another chemical in the mixture, producing potentiation effects. An example of a potentiation effect is the increased toxicity observed with carbon tetrachloride (CCl_4) exposure accompanied by isopropanol. Isopropanol is considered to be relatively nontoxic when administered by itself. However, when administered with CCl_4 , it exacerbates the toxicity of CCl_4 by preventing detoxification mechanisms in the liver from reacting with CCl_4 molecules.
- **Antagonistic Effects** (e.g., $4+(-4)=0$). A mixture in which one or more of the chemicals present inhibits the toxicity of other compounds in the mixture is said to produce antagonistic effects. Antagonistic actions between chemicals serve as the basis for antidotal therapy.

NOTE: Exposure criteria for chemical mixtures do not exist and other information can be very difficult to gather. In situations involving exposure to a mixture of chemicals, it is advisable to assemble a team of experts, including chemists and toxicologists, to characterize the situation completely.

Toxicity Information

Toxicity information is often expressed as the dose of the compound that causes an effect in a percentage of the exposed subjects, which are mostly experimental animals. These dose-response terms are often found in Material Safety Data Sheets (MSDS) and other sources of health information. One dose-response term that is commonly used is the lethal dose 50 (LD_{50}), the dose which is lethal to 50 percent of an animal population from exposure by any route other than inhalation when given all in one dose. Another similar term is the lethal concentration 50 (LC_{50}), which is the concentration of a material in air that on the basis of respiratory exposure in laboratory tests is expected to kill 50 percent of a group of test animals when administered as a single exposure (usually 1 hour).

ACUTE LD_{50} VALUES FOR REPRESENTATIVE CHEMICALS WHEN ADMINISTERED ORALLY TO RATS	
Chemical	Acute Oral LD_{50} (mg/kg)*
Sodium cyanide	6.4 - 10
Pentachlorophenol	50 - 230
Chlordane	83 - 560
Lindane	88 - 91
Toluene	2600 - 7000
Tetrachloroethylene	3000 - 3800
* Milligrams of the compound administered per kilogram body weight of the experimental animal.	

From the above table it can be seen that a dose of 3000 to 3800 mg/kg tetrachloroethylene is lethal to 50 percent of rats that received the compound orally; however, only 6.4 to 10 mg/kg of sodium cyanide is required to produce the same effect. Therefore, compounds with lower LD_{50} values are more acutely toxic than substances with higher LD_{50} values.

The LD_{50} values that appear in an MSDS or in literature must be used with caution by emergency medical personnel. These values are an index of only one type of response and give no indication of the ability of the compound to cause non-lethal, adverse or chronic effects. Furthermore, LD_{50} values typically come from experimental animal studies.

FACTORS INFLUENCING TOXICITY	
TYPE	EXAMPLES
Factors related to the chemical.	Composition (salt, freebase, etc.); physical characteristics (size, liquid, solid, etc.); physical properties (volatility, solubility, etc.); presence of impurities; breakdown products; carriers.
Factors related to exposure.	Dose; concentration; route of exposure (inhalation, ingestion, etc.); duration.
Factors related to person exposed.	Heredity; immunology; nutrition; hormones; age; sex; health status; pre-existing diseases.
Factors related to environment.	Media (air, water, soil, etc.); additional chemicals present; temperature; air pressure.

Exposure Limits

The concept of the various occupational exposure limits which are found in literature or in an MSDS, are based primarily on time-weighted average limits, ceiling values or ceiling concentration limits to which the worker can be exposed without adverse effects.

EXAMPLES OF OCCUPATIONAL EXPOSURE LIMITS		
Value	Abbreviation	Definition
Threshold Limit Value 3 types (ACGIH)*	TLV	Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect.
1) Threshold Limit Value - Time- Weighted Average (ACGIH)*	TLV-TWA	The time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
2) Threshold Limit Value - Short- Term Exposure Limit (ACGIH)*	TLV-STEL	The concentration to which workers can be exposed continuously for a short period of time without suffering from: 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency, and provided that the daily TLV-TWA is not exceeded.
3) Threshold Limit Value - Ceiling (ACGIH)*	TLV-C	The concentration that should not be exceeded during any part of the working exposure.

EXAMPLES OF OCCUPATIONAL EXPOSURE LIMITS		
Value	Abbreviation	Definition
Permissible Exposure Limit (OSHA)**	PEL	Same as TLV-TWA.
Immediately Dangerous to Life and Health (OSHA)**	IDLH	A maximum concentration (in air) from which one could escape within 30-minutes without any escape-impairing symptoms or any irreversible health effects.
Recommended Exposure Limit (NIOSH)***	REL	Highest allowable airborne concentration that is not expected to injure a worker; expressed as a ceiling limit or time-weighted average for an 8 or 10 hour work day.
<p>* American Conference of Governmental Industrial Hygienists</p> <p>** Occupational Safety and Health Administration</p> <p>*** National Institute for Occupational Safety and Health</p>		

The values listed in the above table were established to provide worker protection in occupational settings. Because the settings in which those values are appropriate are quite different from an uncontrolled spill site, it is difficult to interpret how these values should be used by emergency personnel dealing with a hazardous materials incident. At best, TLV, PEL, IDLH, and REL values can be used as benchmarks for determining relative toxicity, and perhaps to assist in selecting appropriate levels of personal protective equipment (PPE). Furthermore, these occupational exposure limits are only useful if the

appropriate instrumentation is available for measuring the levels of toxic chemicals in the air at the chemical spill site. It should be noted that with the above Occupational Exposure Limit values, only the OSHA values are regulatory limits. The ACGIH values are for guidance only and are not regulatory limits.

MCL

MCL (Maximum Contaminant Level). MCLs are mandated by the Safe Drinking Water Act (SWDA) of 1972 and are established by the National Academy of Sciences and EPA to regulate contaminants in public drinking water supplies. MCL values are changed regularly to reflect improvements in treatment technologies.

Frequently, one chemical will have several exposure values associated with it. The field investigator should evaluate these numbers on the basis of the tasks to be performed on site and the personal protection equipment to be used to ensure exposure limits are not exceeded. Within this context, the most conservative exposure value (i.e., the lowest value) should be chosen to provide for the greatest site security.

Practical Considerations

The answers to the following questions will dictate how response personnel are protected (type of respiratory and protective gear employed):

- What toxic agent is present?
- How much of the agent is present?
- How will it enter the body?
- How will it affect the body?

APPENDIX 2

Environmental Media

Air, soil, and water are the environmental media through which exposure to toxic substances occurs. Awareness of the properties of each medium aids in evaluating routes of exposure and in determining sample locations. In making these determinations, it is also important to consider the impact the prevailing weather conditions in an area have on the air, soil, and water on site.

Air

Air contaminants may pose an inhalation, ingestion, and direct contact threat to the public over very large areas downwind of the site. Sudden, unexpected shifts in wind direction are of particular concern because they can cause exposure to site workers and the public in areas previously considered to be safe. Wind direction and speed are the primary factors governing transport of air contaminants -- both gases and particulates. Winds arise from horizontal pressure gradients in the atmosphere and can change rapidly in direction and speed in the vicinity of fronts. Some locations, such as mountainous areas and areas along large lakes, experience diurnal fluctuations in wind direction caused by daily temperature changes. These daily changes also enhance contaminant dispersion.

Air releases include volatilization from contaminated soils, covered landfills (with and without internal gas generation), spills and leaks from containment facilities, and lagoons. Contaminant releases into the atmosphere may also consist of fugitive dusts resulting from wind erosion of contaminated soils and from traffic over contaminated, unpaved roadways. When a stable suspension of dust or other solid particles or of liquid droplets in air occurs, it is called an aerosol.

Temperature and atmospheric pressure influence the rate of air releases. With increasing temperature, the rate of volatilization of compounds tends to increase. Volatiles may be released from liquids even on cold days because solar radiation can increase the temperature of a liquid more rapidly than the temperature of air. Temperature also governs atmospheric stability, which is the degree to which the atmosphere dampens vertical motion. In an unstable atmosphere, the temperature decreases rapidly with increasing elevation, resulting in turbulence (wind). In a stable atmosphere, the temperature may remain constant throughout the column of air or, in the case of an inversion, even increase with elevation. Stable conditions typically occur in late afternoon through early morning under clear skies with light winds. Atmospheric pressure tends to affect the migration of landfill gases, causing a landfill to offgas at a higher rate following low atmospheric pressures. When the atmospheric pressure is high, the landfill may cease offgassing entirely.

Humidity is not a factor in the generation and transport of air contaminants. It can influence the hazards of a release, however. In the case of a release of hydrogen chloride gas, for example, the hazards posed by hydrochloric acid should be considered, especially on an extremely humid day.

DISPERSION MECHANISMS

The relative directional frequencies of wind over a site determine the primary direction of movement of airborne contaminants - both gases and particulates. Wind speed and direction are influenced not only by meteorological conditions, but also by the topography of an area. Even tall buildings and other large structures can influence wind speed and direction in small, localized areas.

Atmospheric stability and wind speeds determine the off-site areas to be affected by ambient concentrations of gases. In general, high stability and low wind speeds result in higher atmospheric concentrations of contaminant gases close to the site. High stability and moderate wind speeds result in moderate concentrations over a large area downwind of the site. Low stability or high wind speeds cause greater dispersion and dilution of contaminants, resulting in lower concentrations over larger areas.

Wind speed is a critical factor in generating airborne contaminated particulate material. At higher speeds, the turbulence of the air and its forward motion lifts particles into the windstream for transport. Under windy conditions, transport of contaminated particulates, especially of metals, dioxin, and PCB contamination, can pose significant health threats downwind of the site. Transport of contaminated particulates is generally not a concern when the soil is wet because of the increased threshold wind speed required to make the particles airborne.

Ambient concentrations of particulate contaminants are controlled by particle size distribution as well as by windspeed and stability. Large particles settle out rapidly, resulting in decreased atmospheric concentrations with distance from the site. Smaller particles remain airborne longer and approximate the behavior of gaseous contaminants.

INTERMEDIA TRANSFER MECHANISMS

Settleout and rainout are mechanisms of contaminant transfer from the atmosphere to surface soils and waters. Contaminants dissolved in rainwater may percolate to groundwater, run off or fall directly into surface waters, and adsorb to uncontaminated soils. Contaminants can enter the food chain through direct intake of the atmosphere by plants and animals and through intake of secondarily contaminated soils and water.

Soils

Soil represents a medium of direct contact and ingestion threats and may be the main source of contaminants released into other media (air, water). Direct soil contamination occurs from leaks or spills from containers and containment facilities. The spilled liquids and solids may be transported through soil or may be partially or fully retained within the soil to provide a continuous environmental and/or public health threat. At the site of a release and along the release pathway, discolored soils, stressed or dead vegetation, and uncharacteristic odors may be preliminary indicators of soil contamination.

DISPERSION MECHANISMS

To predict the fate and transport of a hazardous substance released onto the soil surface, the properties of both the substance spilled and the soil must be considered. The mobility of a material in soil is influenced by many factors, such as soil type, temperature, porosity, and biological and chemical activity, along with the water solubility, vapor pressure, and physical state of the substance released. Liquid movement is the most significant dispersion mechanism in soils. Liquid contaminants percolate directly into soils, and contaminants of lower viscosity and/or higher density than water can have percolation rates much greater than that of water. Dry, soluble contaminants dissolved in precipitation, or in runoff or irrigation water can also migrate through percolation into the soil and through runoff. The rate of movement of solid contaminants through soil is a function of net groundwater recharge rates and of contaminant solubility.

Contaminants with high soil adsorption coefficients (e.g., benzo-a-pyrene) may bind (adsorb) to the surface of soil particles through ion exchange and become relatively immobile under certain conditions. However, adsorbed contaminants may later be desorbed by percolating waters, causing the contaminants to become mobile again. Movement of airborne or waterborne soil particles with hazardous substances adsorbed to the surface also contributes to spread of contamination.

To determine in detail how a release may behave, it is necessary to establish the predominant nature of the soils on site. It is also

important to establish whether such underground features as clay layers, sink holes, and fractures are present. These and other subsurface features can greatly facilitate or retard the spread of contamination and influence the direction of movement.

INTERMEDIA TRANSFER MECHANISMS

Releases which occur on soils with low runoff potential, such as well-drained sandy or gravelly soils, have a high infiltration rate. Spills on these types of soils will migrate off site rapidly and may present a threat to groundwater. Loamy and clay soils with a moderate to high runoff potential provide a low infiltration rate and a surface conducive to overland flow. Releases occurring on these types of soils may create a hazard at some distance to the site as the spilled substance travels overland to surface waterways, or as vapors from the substance volatilize into the atmosphere or collect in such confined spaces as culverts and sewers. Biouptake by plants and soil organisms is another transfer mechanism of soil contaminants and one which introduces the contaminants to the food chain.

Water

Water contamination poses ingestion and direct contact threats. Water also transports contaminants through soil and acts as a vehicle for intermedia transfer of contaminants to air and soil. Water has two important characteristics, its strongly dipolar nature and the ability of water molecules to form hydrogen bonds with the oxygen ends of adjacent water molecules. The dipolar nature of water is the reason for its solvent properties; the force of attraction between the dipole and ions on the surface of a contaminant or other substance can cause the contaminant to form a solution with water.

The ability of water molecules to form hydrogen bonds with each other accounts for the high dynamic viscosity and high surface tension of water, as well as its melting and boiling points. Both the viscosity and surface tension of water affect transport of particulate

the movement of groundwater. Viscosity and surface tension each decrease as temperature increases.

The properties of the contaminant are important to consider when assessing the threat posed by water contamination. Such characteristics as solubility, vapor pressure, specific gravity, and dispersability affect the behavior of the contaminant in water and influence cleanup techniques.

DISPERSION MECHANISMS

Direct surface water contamination occurs from releases into a body of water or from contaminated runoff. Dispersion of contaminants through surface waterways is affected by currents and eddies in rivers, streams, lakes, and estuaries, and also by thermal stratification, tidal pumping, and flushing. Contaminant concentrations in rivers or streams can be estimated on the basis of rate of contaminant introduction and dilution volumes. Estimates of contaminant concentrations in estuaries and impoundments are more difficult to make because of the variety of transport mechanisms that may be involved, causing contaminants to remain concentrated in local areas or to disperse rapidly.

Direct groundwater contamination can occur from liquids and solids in lined or unlined landfills, lined or unlined lagoons, underground storage tanks, injection wells, or long-term surface dumping. Dispersion of contaminants through groundwater is influenced by a variety of factors such as the hydraulic conductivity of soils; the hydraulic gradient; the presence of impermeable subsurface barriers; the presence of discharge areas (e.g., streams that intercept ground water flow), and the presence of fissures, cavities, or large pores in the bedrock.

INTERMEDIA TRANSFER MECHANISMS

An important intermedia transfer mechanism in surface water is contaminant transfer to bed sediments, especially in cases where

contaminants are in the form of suspended solids or are dissolved, hydrophobic substances that can be adsorbed by organic matter in bed sediments. Transfer between surface water and bed sediments is reversible, and the sediments can act as temporary repositories for contaminants, gradually releasing contaminants to surface water. In addition, adsorbed or settled contaminants can be transported through migration of bed sediments.

Transfer of contamination between surface water and groundwater occurs in areas of substantial surface-groundwater exchange, such as in swamps and marshes. Surface water contamination enters the food chain through biouptake by plants and animals. Transfer to the atmosphere occurs where the surface water is contaminated with volatile substances. Such transfer can pose a threat of explosion as vapors collect in sewers and other enclosed spaces. High temperatures, high surface area-to-volume ratios, high wind conditions, and turbulent stream flow increase volatilization rates. Volatiles in groundwater can be transferred to the atmosphere at household taps. Inhalation of volatiles while bathing may be a potentially significant route of exposure for residents whose potable water is contaminated with volatile organic compounds.

APPENDIX 3

Sampling and Basic Data Interpretation

Together, sampling, sample analysis, and basic interpretation of analytical results form the most effective mechanism for obtaining definitive information to characterize site conditions, evaluate the threats to human health and the environment, support compliance and enforcement activities, justify site cleanup activities, and determine cleanup effectiveness.

The type and number of samples collected, the manner in which the samples are collected, and the analyses chosen depend on what the EPA investigator wants to ascertain. The sampling plan is the vehicle for securing a set of quality-controlled samples that reflect site conditions accurately and provide the information desired. The sampling plan outlines all sample locations, collection procedures, and analytical methods to be used in a sampling episode.

Once the samples have been analyzed by a laboratory, basic interpretation of the results can be confusing because of the different formats used by various laboratories to report analytical results. Nevertheless, there are a few standard terms used by laboratories to report the concentrations of the analytes. In addition, quality assurance parameters have been established through common laboratory practices to provide a means of measuring both the accuracy and precision of analysis and of ensuring that no external contamination was introduced by sample collection and analysis procedures.

This appendix is divided into four sections. The first section covers the topics addressed in the sampling plan. The second defines the types of quality assurance samples and a few additional sampling terms. The third section covers basic data interpretation, including qualifier codes used in sample analysis reports produced by laboratories in EPA's Contract Laboratory Program (CLP). The fourth section deals with data validation procedures.

Sampling Plans

Complete site sampling plans should address each of the following topics to ensure that the appropriate protocols are observed during the sample collection and analysis processes and to enable the sampling procedures to be duplicated, if necessary. Samples are not only used as a source of information for making site decisions, they may also be used for legal purposes, so complete documentation of the actual sampling event is important.

- **Representative Sample Locations.** Representative sampling locations depend on the purpose of the sampling activity. The intended data use will guide determination of the sampling locations and pattern and total number of samples. Contamination verification requires fewer samples biased toward suspected areas of contamination; such samples may not give an accurate presentation of the overall site characterization, however. A better overall characterization may be achieved using a grid pattern to determine sample locations. Use of a grid system generally increases the number of samples collected, thus increasing analytical costs. For further information, consult guidance documents published by the EPA Office of Solid Waste and Emergency Response on representative sampling of soil, water, and hazardous wastes and on sample collection and handling techniques.
- **Analysis Selection.** Specific parameters for analysis must be established while assembling the sampling plan. The laboratory should be notified and given the EPA-approved method number

and the desired QA/QC information. The analysis selected influences the choice of sample equipment, volume, preservation, and holding time. A summary of sample container types, preservatives, holding times, and analytical methods is included at the end of this section. The EPA publication Solid Waste 846 (SW-846), "Test Methods for Evaluating Solid Waste," gives information on analysis methods for hazardous wastes, soils, and non-aqueous phase liquids. EPA 500 and 600 publications cover test methods for water.

- **Quality Assurance Level.** The level of quality assurance (QA) that the sampling event must meet should be established at the outset, as the level selected affects the sample handling, documentation, and analysis procedures used. QA Level 1, the least stringent level, requires sample documentation and instrument calibration/performance checks; samples are field screened.

QA 1 applies when a large amount of data is needed quickly and relatively inexpensively, or when preliminary screening data does not need to be analyte or concentration specific. Examples of activities where QA 1 is appropriate include assessing preliminary on-site health and safety, assessing waste compatibility, characterizing hazardous waste, and determining extent of contamination.

QA 2, which verifies analytical results, requires external laboratory analysis of at least 10 percent of field-screened samples, sample documentation, chain-of-custody documentation, documentation of sample holding times, and raw instrument data. To meet the QA 2 objective, samples are analyzed using rigorous methods that provide quantitation and analyte-specific information. Examples of activities where QA 2 is appropriate include verifying preliminary screening, defining extent and degree of contamination, and verifying site cleanup.

QA 3, the most stringent level, assesses the identity of the analyte of interest and the analytical error of the concentration level. QA 3 incorporates the specifications for QA 2 and also requires the analysis of eight replicate samples to determine analytical error and analysis of a performance evaluation sample. This level of quality assurance is used when determination of

analytical precision in a certain concentration range is crucial for decision making. Examples of activities where QA 3 is appropriate include evaluating health risk or environmental impact, identifying the source of pollution, and verifying cleanup.

- **Sampling Equipment Selection.** The type of sampling equipment is dictated by the analysis selection, required sample volume, ability of decontamination, equipment composition, and cost. The sampling equipment should not introduce contamination into the sampling procedure. To avoid this, sampling equipment should be disposable or easily decontaminated. Disposable equipment must be economical or used when extensive decontamination would be required for durable sampling equipment. The equipment must also be functional, allowing a sampling team to collect samples quickly and efficiently. The composition or construction materials of sampling equipment may affect the samples collected and so must be considered when selecting equipment.
- **Sampling Volumes.** Sampling volumes are directly related to the types of chemical analyses that are requested. The laboratory requires a precise amount of a sample unique to the specified EPA-approved analysis or method. Providing the laboratory with an excess of sample volume increases the eventual disposal costs to the laboratory and in turn to the samplers. Providing the laboratory with insufficient volume can lead to increased field sampling costs and to delays.
- **Sampling Containers.** The type, size, and composition of sampling containers are directly related to the chemical analysis which is requested. The size of the container must conform to volume requirements specified in the EPA-approved method. The container must not release contaminants into the sample or absorb material from the sample. The container must ensure that ambient air cannot enter into the sample, and conversely, that gas from the sample cannot escape to the ambient air.
- **Sample Preservation.** Samples are preserved by means of environmental controls (e.g., cold storage) or chemical additives

(e.g., nitric acid or sodium hydroxide). The preservation method is directly related to the chemical analysis requested. The purpose of preservation is to keep the chemical constituents of the samples static during handling, packing, and shipment to the laboratory. Highly concentrated samples do not usually require preservation.

- **Sample Holding Times.** The elapsed time between sample collection and laboratory analysis must be within a predetermined time frame known as the sample holding time. Each sample parameter has a prescribed holding time. Samples analyzed beyond the holding time are not truly representative of the sampled material.
- **Sample Identification.** Each sample must be identified and documented to ensure sample tracking is performed. A label is made for each sample, reflecting the site name, site location, sample number, date and time of sampling, sampler identification, preservative used, required analysis, and sampling location description.
- **Sample Custody.** Chain-of-custody forms are used to track the handling of samples once the samples are collected. The samples are documented as they are transferred from each handler or to the laboratory. The procedure is used to prevent sample tampering and to trace the path of a sample in the event of contamination off site. Chain-of-custody seals are applied as directed by protocol.
- **Sample Transportation.** Samples may be hand delivered to the laboratory using government vehicles or they may be shipped by a common carrier. Regulations for packaging, marking, labeling, and shipping of hazardous materials and wastes are promulgated by the U.S. Department of Transportation (DOT). Air carriers which transport hazardous materials, in particular, Federal Express, require compliance with the current International Air Transport Association (IATA) Regulations, which applies to the shipment and transport of hazardous materials by air carrier. Hazardous waste site samples should not be transported in personal vehicles.

A126 SAMPLING AND BASIC DATA INTERPRETATION A126

	Analytical Parameter	Matrix	Container Type and Volume (# containers req'd)	Preservative degrees Celsius	Holding Times	Trip Blanks (VOAs)	Analytical Method Ref.
	VOA	S	40 ml Vial (2)	4	14 Days	Yes	8240 or 8260/ SW846
	VOA	W	40 ml Vial (3)	4*	14 Days	Yes	624/CLP
	BNA	S	8 oz Glass (1)	4	7 - 40 Days		8250 or 8270 SW-846
	BNA	W	32 oz Amber Glass (1)	4	7 - 40 Days		625/CLP
One Bottle Per Medium to test Pes/ PCBs Together	Pesticide	S	8 oz Glass (1)	4	7 - 40 Days		8080/SW-846
	Pesticide	W	32 oz Amber glass (1)	4*	7 - 40 Days		608
	PCB	S	8 oz Glass	4	7 - 40 Days		8080/SW-846
	PCB	W	32 oz Amber Glass (1)	4*	7 - 40 Days		608
	P.P. Metals	S	8 oz Glass	4	6*** Months		SW-846
	P.P. Metals	W	1 liter Glass or polyethylene (1)	HNO ₃ pH < 2 4	*** 6 Months		EPA-600/ CFR 40
	Cyanide	S	8 oz Glass (1)	4	14 Days		SW-846
	Cyanide	W	1 liter Polyethylene (1)	NaOH to pH > 12 4	14 Days		SW-846

* If residual chlorine is present, preserve with 0.008% N₂S₂O₃.

** Only required if dedicated sampling tools are not used.

*** Exceptions - mercury (28 days) and hexavalent chromium (24 hours - water).

NOTE: Nitric acid (HNO₃); Sodium thiosulfate (N₂S₂O₃); Hydrochloric Acid (HCl)

Terminology

- **Accuracy.** Accuracy may be defined as the measure of the closeness to a true or accepted value.
- **Background sample.** A background sample is a sample collected upgradient of the area of contamination (either on or off site) where there is little chance of migration of contaminants. Properly collected background samples indicate the natural composition of the matrix and should be considered clean samples.
- **Collocated Sample.** A sample collected adjacent to the basic field sample, typically one-half to three feet away from the sample location. Collocated samples are used to assess variation in the immediate area of the basic sample.
- **Field Blank.** A field blank is a sample of laboratory pure water or certified clean soil which is prepared in the field prior to any sampling activities. Analysis of the sample will indicate whether contamination was introduced into the samples during the collection process.
- **Field Duplicate.** A field duplicate (or replicate) is a second sample (or set of samples) collected from one sample location and labeled for the laboratory as if it were a unique sample. Field duplicates are primarily used to check the precision and consistency of the sampling procedures used. The field duplicate can also act as a check on the analytical procedures.
- **Holding Times.** Holding times are the timeframe within which the sample must be analyzed to ensure accurate measurement of the analytes. Holding times vary depending on the type of analysis to be performed.
- **Laboratory Duplicate.** Laboratory duplicates are samples prepared by the laboratory and analyzed in duplicate to measure analytical reproducibility.

- **Matrix Spike/Matrix Spike Duplicate.** A matrix spike sample is a sample to which a target compound at a known concentration is added during laboratory preparation to measure the accuracy of the analysis procedure. A matrix spike duplicate is a second run to determine the precision of analysis. Such samples are primarily used to check sample matrix interferences, but can be used to monitor laboratory performance.
- **Method Blank.** A method blank is a sample which is prepared by the laboratory to determine if any contamination is being introduced during the extraction or analysis procedures.
- **Method Detection Limit.** The method detection limit (MDL) is the lowest concentration that can be measured if a sample is analyzed according to the method procedures.
- **Performance Evaluation Samples.** Performance evaluation (PE) samples are samples of known concentrations that are available from either the EPA or the U.S. Bureau of Standards for submission with the field samples to the laboratory. PE samples should be of the same or similar matrix as the field samples. PE samples are used to check the overall bias of the laboratory and to detect any error in the analytical method used.
- **Precision.** Precision may be defined as the agreement between the numerical values of two or more measurements made in an identical fashion.
- **Relative Percent Difference.** The relative percent difference (RPD) is used to assess the variability of a measurement process. Typically, the value represents the difference between the matrix spike and the matrix spike duplicate. It can also represent the difference between two analysis runs.
- **Rinsate Blank.** A rinsate blank is a sample of laboratory pure water run over sampling equipment following decontamination. Rinsate blanks are used to check decontamination effectiveness.

- **Split Samples.** Split samples are derived from one large volume sample obtained from one location, then thoroughly homogenized, and divided into separate portions. Each portion, or split, is placed into a separate container and treated as a separate sample. Samples can be split two or more ways, and the total sample volume depends on the number of splits and the analytic method to be used. Split samples are usually collected when a responsible party and EPA Enforcement Section or several government agencies are involved. Split samples, which typically are sent to different laboratories for analysis, act as a check on the laboratory.
- **Surrogate Spike.** A surrogate spike refers to a procedure in which a non-target compound is added to the sample during laboratory preparation to determine the extraction efficiency. Surrogate spikes are usually used only with organics.
- **Trip Blank.** A trip blank is a sample which is prepared prior to the sampling trip using laboratory pure water or certified clean soil. This sample travels to the assessment and is kept with the other samples but is not opened in the field. Analysis of the trip blank will indicate whether the sample containers were contaminated prior to the assessment.

A130 SAMPLING AND BASIC DATA INTERPRETATION A130

Basic Data Interpretation

CONCENTRATION UNITS FOR ANALYSIS

Water (Aqueous)	ppm = ug/mL or mg/L ppb = ng/mL or ug/L ppt = ng/L
Soil or Sediment	ppm = ug/g or mg/kg ppb = ng/g or ug/kg ppt = ng/kg
Air	mg/m ³ , ng/m ³ (temperature and pressure dependent) ppm or ppb (unitless measurement)
Oils or Organics	The concentrations of oils or organics should be expressed using the soil units listed above. Laboratory results that report concentrations for oils or organics using water units should be questioned.

GLOSSARY OF SOME COMMON DATA QUALIFIER CODES AND TERMINOLOGY USED IN THE EPA CONTRACT LABORATORY PROGRAM (CLP)

CODES RELATING TO IDENTIFICATION

(indicate confidence concerning presence or absence of compounds)

U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.

B = Not detected substantially above the level reported in laboratory or field blanks.

A131 SAMPLING AND BASIC DATA INTERPRETATION A131

R = Unreliable result. Analyte may or may not be present in the sample. Supporting data is necessary to confirm result.

N = Tentative identification. Consider analyte present. Additional sampling and special methods may be needed to confirm its presence or absence.

(NO CODE) = Confirmed identification

CODES RELATED TO QUANTITATION

(indicate positive results and sample quantitation limits)

J = Analyte present; reported value may not be accurate or precise.

K = Analyte present; reported value may be biased high. Actual value is expected to be lower.

L = Analyte present; reported value may be biased low. Actual value is expected to be higher.

UJ = Not detected; quantitation limit may be inaccurate or imprecise.

UL = Not detected; quantitation limit is probably higher.

OTHER CODES

Q = No analytical result.

Data Validation Procedures

Data validation is the process by which a qualified data reviewer ensures the quality of the laboratory analysis and the reported results. The procedures used to validate a data package vary slightly according to the type of analysis performed and the instrumentation used. Many times, data validation requires the reviewer to draw upon his or her analytical experience and expertise to make subjective decisions about the quality of a set of results. For this reason, data validation should be completed only by qualified persons.

Data validation procedures vary, depending on the type of instrumentation and methods used for analysis. For the sake of simplicity, the example below outlines the validation procedures for analytical results from a Gas Chromatograph/Mass Spectrometer (GC/MS). While validation of analyses performed on other types of instruments would not be an identical process, it would be similar.

EXAMPLE DATA VALIDATION PROCEDURES FOR GC/MS

- 1. Did the laboratory meet the holding times outlined by the sampling protocol?**
 - If yes, accept data.
 - If no, data should be accepted as estimates only.
- 2. Was the GC/MS properly tuned?**
 - If yes, accept the data.
 - If no, reject all GC/MS data because compounds may be misidentified.
- 3. Was the instrument properly calibrated?**
 - If yes, accept the data.
 - If no, data should be accepted as estimates only.
- 4. Were method blanks free of contamination?**
 - If yes, accept the data; further action is not required.
 - If no, determine if the contamination was the result of a common laboratory chemical. Sample data should only be rejected if the analyte concentration is less than three times the contaminant concentration in the blank.

5. Were field blanks free of contamination?

- If yes, accept the data; further action is not required.
- If no, determine if the contamination was the result of a common laboratory chemical. Sample data should only be rejected if the analyte concentration is less than three times the contaminant concentration in the blank.

6. Were the surrogate spike recoveries for all organics acceptable?

- If yes, accept the data.
- If no, evaluate each sample on an individual basis and accept or reject the data as necessary.

7. Were the matrix spike recoveries and the relative percent differences values acceptable?

- If yes, the laboratory has demonstrated good precision and accuracy; accept the data.
- If no, evaluate on per compound basis.

Additional Guidance Documents

1986. EPA. "Test Methods for Evaluating Solid Waste," SW-846. Office of Solid Waste and Emergency Response. Washington, DC. November.

1990. EPA (U.S. Environmental Protection Agency). "Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures." Interim Final. EPA/540/G-90/004. Office of Emergency and Remedial Response. Washington, DC. April.

1993. EPA. "Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses." EPA Region III Office of Analytical Services and Quality Assurance. Annapolis, MD. April.

1994. EPA. "Region III Modifications to National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (OLM01.0-OLM01.9)." EPA Region III Office of Analytical Services and Quality Assurance. Annapolis, MD. September.

A134 SAMPLING AND BASIC DATA INTERPRETATION A134

U.S. Office of Federal Register. "Code of Federal Regulations," 40 CFR, Part 136. Office of Federal Register National Archives and Records Administration. Washington, DC.

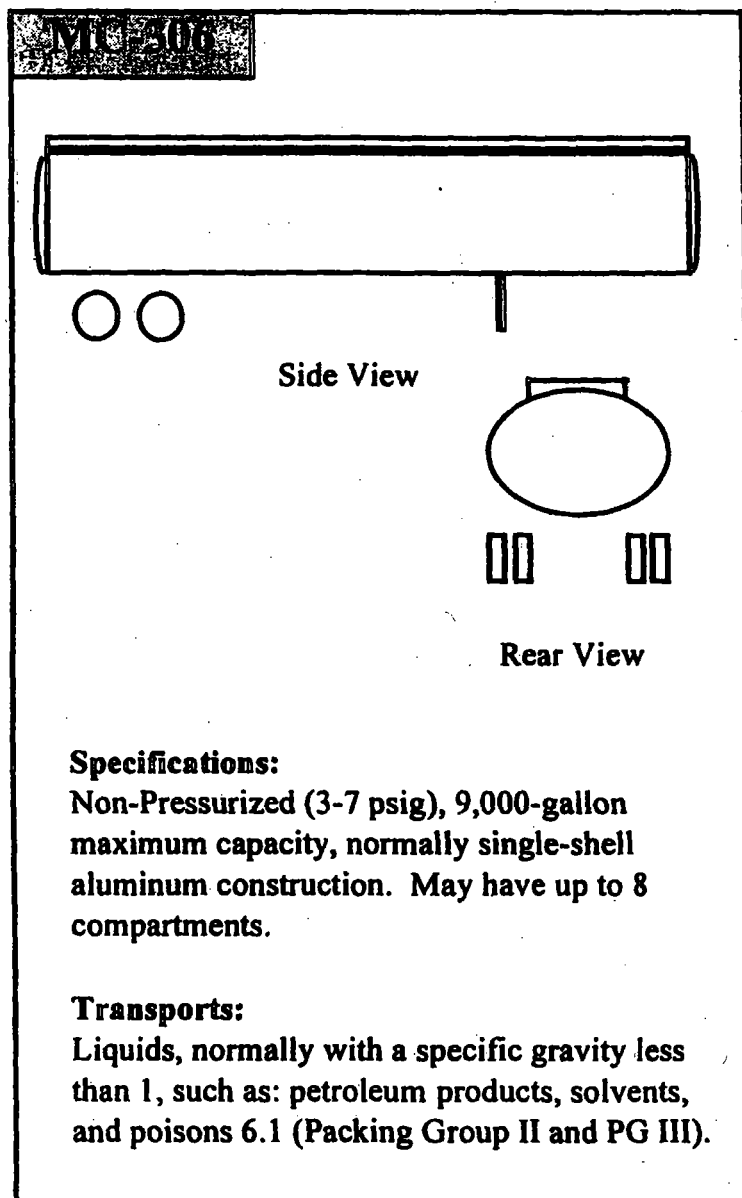
APPENDIX 4

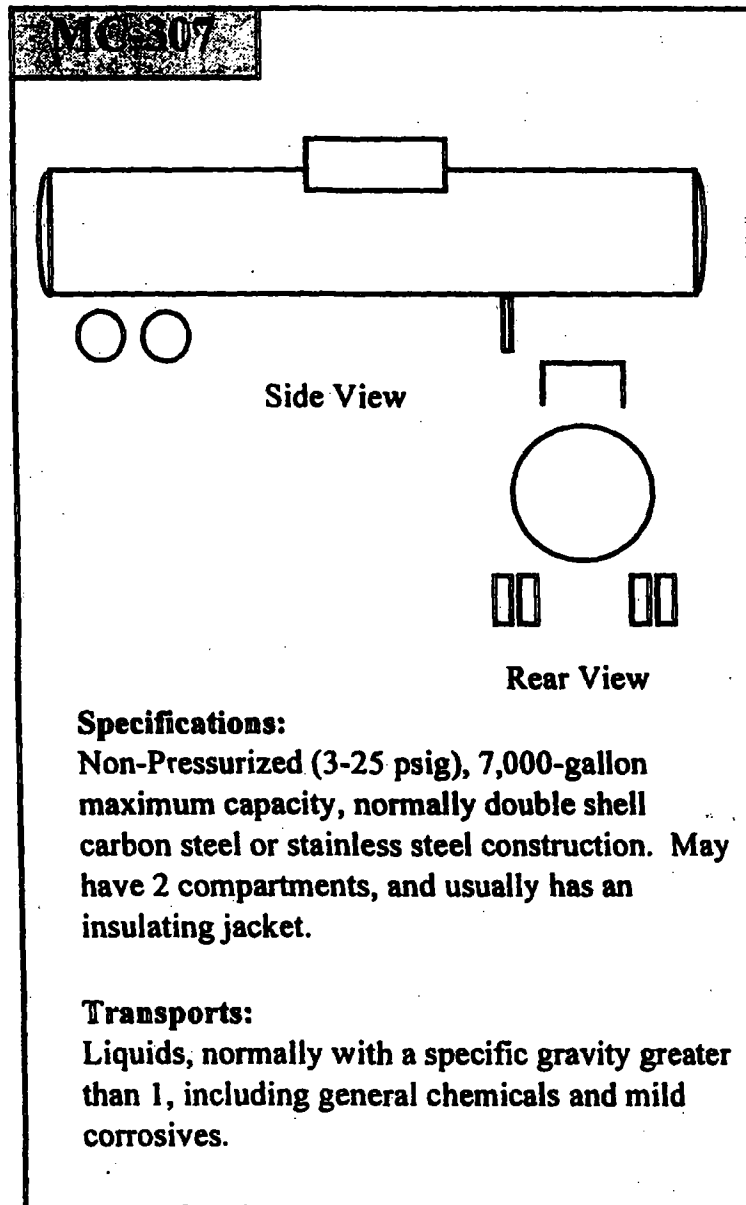
Container Silhouettes

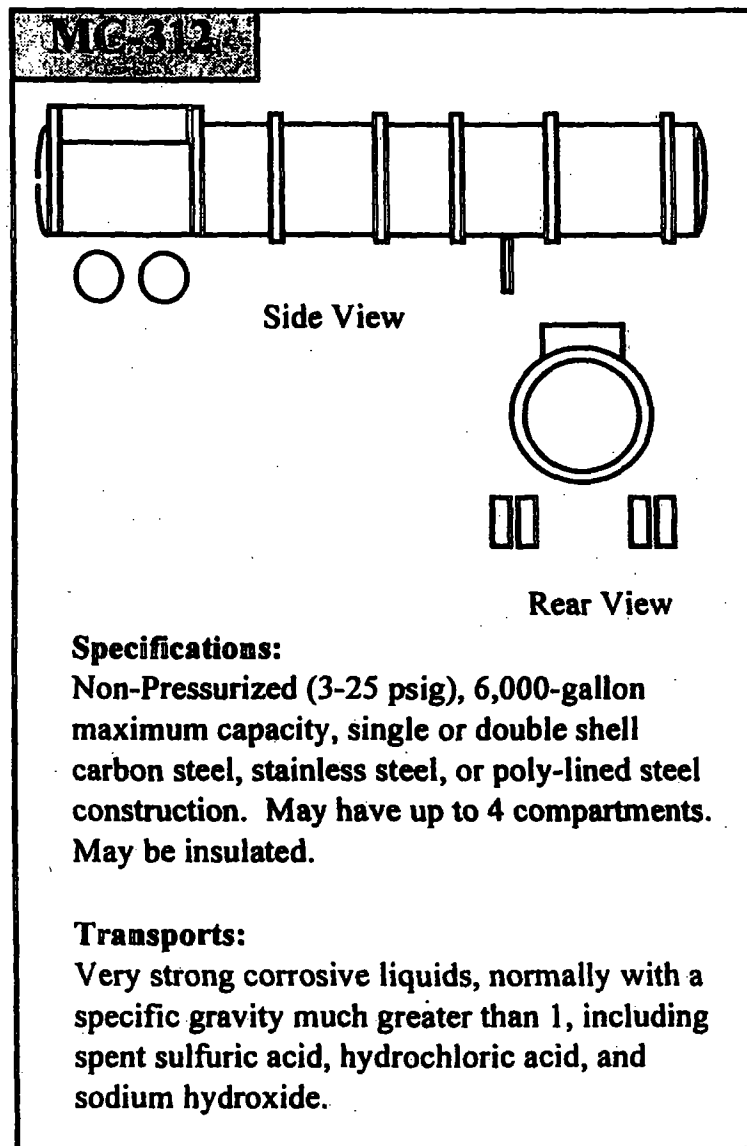
By using common sense, looking at what a container is made of and how it is constructed, responders can get some quick clues and general ideas about the material inside. Look for things like the construction material of the container (steel, stainless steel, plastic, fiberboard, glass, etc.) to make a rough determination as to its contents. Steel containers usually do not contain corrosive materials or oxidizing materials because these materials corrode steel. Plastic containers usually do not contain solvents or flammable materials because these materials usually dissolve plastics. Stainless steel containers are expensive to construct and are usually reserved for very corrosive materials or very strong oxidizers (materials which may destroy other types of steel and plastics). Fiberboard containers usually contain solid materials. Glass containers are used for a wide variety of materials. Look for other container clues as well, such as rounded or spherical shape (usually associated with pressurized materials), color (amber glass may contain light-sensitive materials), and types of openings (bungs, valves, ring-tops, etc.). All of these clues may help to identify the type of hazardous material involved.

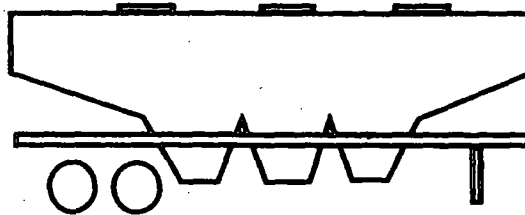
Over-the-Road Transport, Non-Pressurized

Of all the containers encountered, these are probably the most common. They can contain almost anything, and are all regulated by DOT with regards to construction and specification. The listing that follows specifies the DOT designation and provides a general description of the types of materials carried and a generic outline of the tank in question.

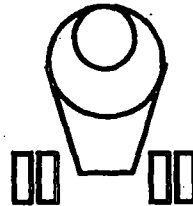






PNEUMATIC HOPPER TRAILERS

Side View



Rear View

Specifications:

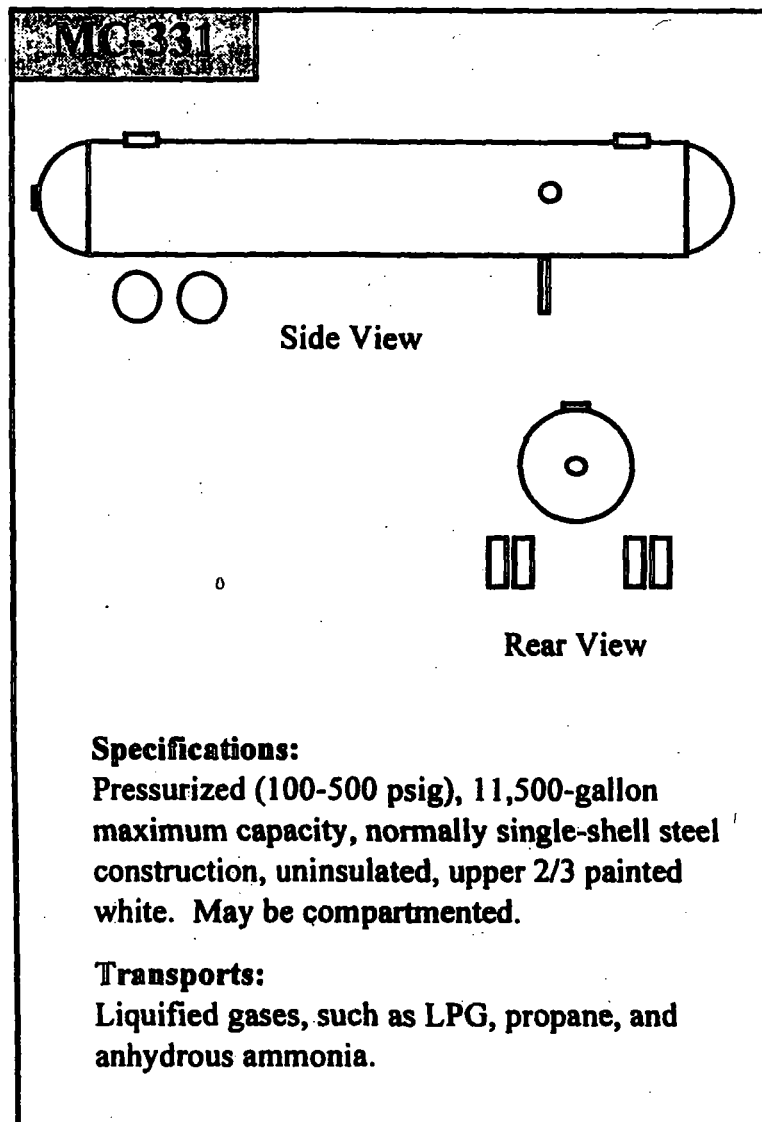
Non-Pressurized (3-25 psig), 1,500-cubic feet maximum capacity, usually single-shell aluminum or steel construction. May have up to 4 compartments.

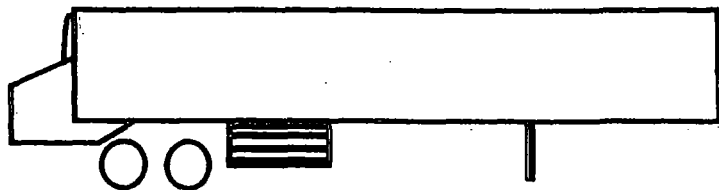
Transports:

Solids in powder form such as fertilizers, cement, and dry caustic soda.

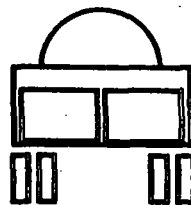
Over-the-Road Transport, Pressurized

These containers are also regulated by DOT, however they pose some slightly different hazards to responders than the non-pressurized containers. Pressurized containers may contain gases, liquified gases, or cryogenic materials, dependant upon the specific tank involved. In almost all cases, the materials these containers hold will be gases when released into the environment. This creates some significant hazards for responders, since gases usually have the greatest potential for migration, and therefore the greatest potential to impact a large area and a large number of people. Unfortunately, gases are also probably the most difficult state of matter to contain and control.



MC-338

Side View



Rear View

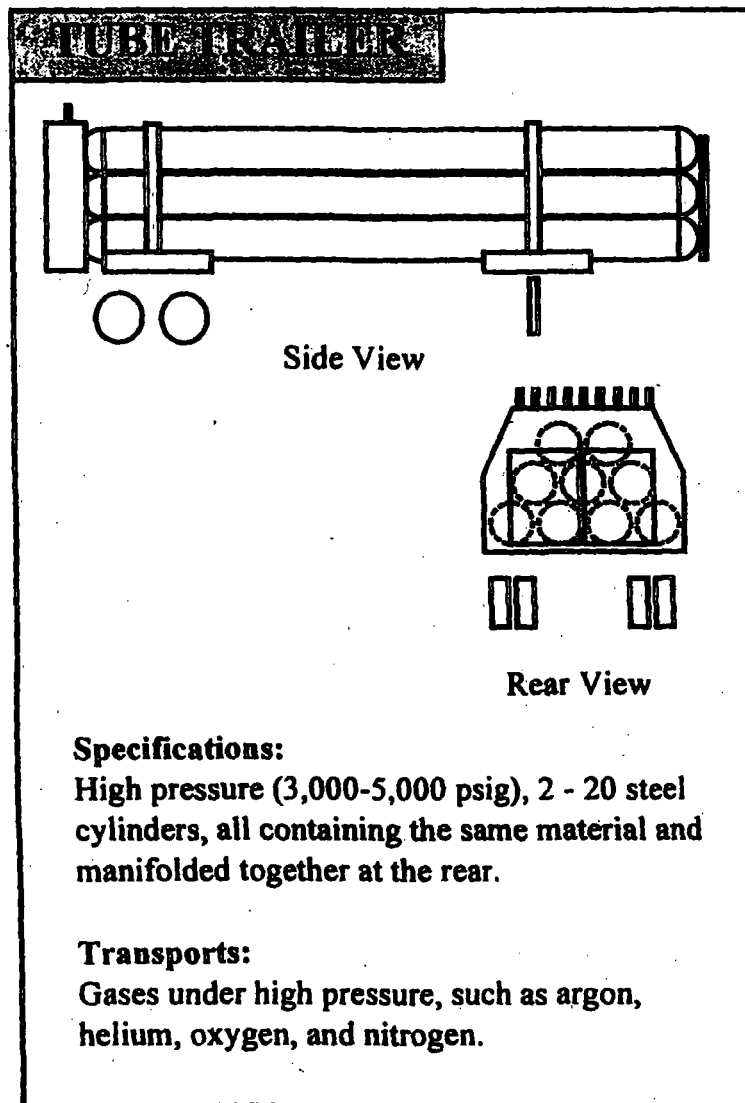
Specifications:

Pressurized (25-500 psig), 14,000-gallon maximum capacity, normally double-shell steel.

Single compartments with relief valves (normally venting during operations).

Transports:

Liquified, cryogenic (-150°F or less) gases such as liquid nitrogen, liquid oxygen, and liquid carbon dioxide.

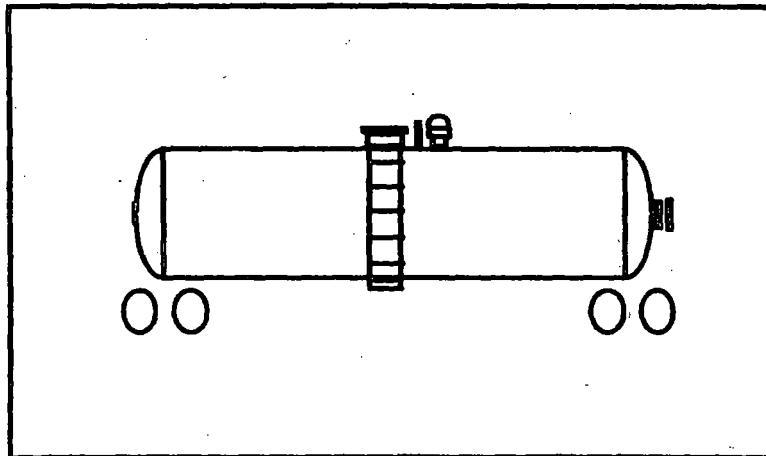


Rail Transport Containers

In general, rail cars pose significant problems to responders as a result of the quantity of material involved. Mitigation of an incident involving a rail car can tax resources, because in many instances local response organizations may not have the type or amount of mitigation resources required. In addition, rail cars involved in accidents can be damaged severely. These types of accidents can last for several days, pose substantial threats to the public and responders, and result in the release of large amounts of materials.

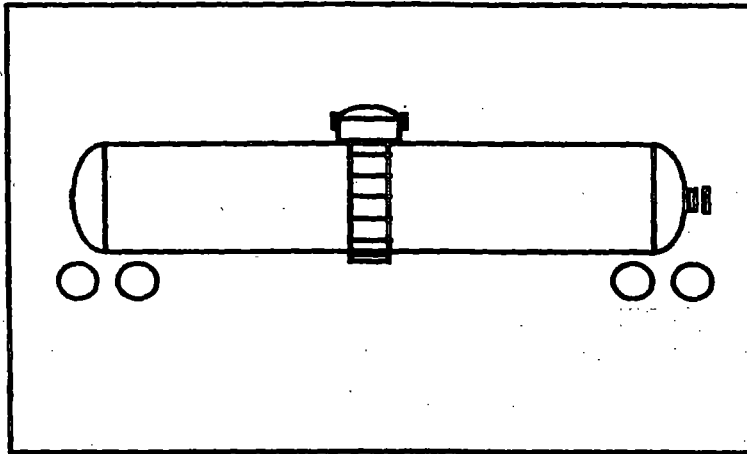
Rail, Non-Pressurized

Unlike over-the-road containers, it is not possible to determine whether a rail car is non-pressurized by the shape of the tank. Rail cars almost always have some type of an insulating jacket. This makes it impossible to see the tank and determine its shape. For rail cars, the best method of determining non-pressurized cars from pressurized cars is to look at the manway area on top of the car. Non-pressurized cars have a large, bolted manway with several fittings (relief valves, gauging rods, etc.) around it which are relatively unprotected. They will usually also have off-loading valves on the sides or bottom of the car.

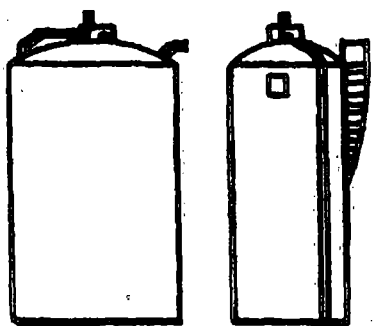


Rail, Pressurized

Pressurized rail cars will have a well-protected dome covering the valving assembly on top of the car. This dome is normally locked closed, and protects all of the off-loading valves and relief valves on the car. There will be no other valving visible on the car.

**Fixed Facility, Non-Pressurized**

Fixed facility containers can contain almost anything. These containers are normally fixed in place, and may be extremely large (containing millions of gallons of material, in some cases). Non-pressurized fixed facility containers, more correctly termed "atmospheric" tanks since they are generally at ambient atmospheric pressures, can normally be identified by reviewing the construction. These tanks may have dome roofs, geodesic dome roofs, floating roofs, or simply flat roofs. They are normally not constructed with rounded ends or edges.



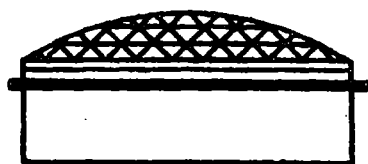
Dome Roof Tank
STORES: flammable and combustible liquids, chemical solvents, etc.



Cone Roof Tank
STORES: flammable, combustible, and corrosive liquids



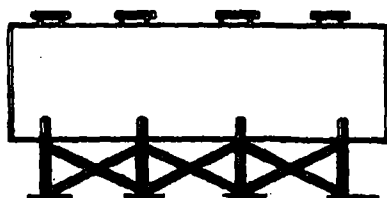
Open Floating Roof Tank
STORES: flammable and combustible liquids



Open Floating Roof Tank with Geodesic Dome
STORES: flammable liquids



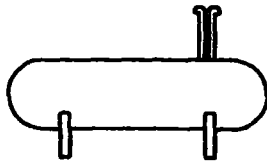
**Covered Floating
Roof Tank**
**STORES: flammable and
combustible liquids**



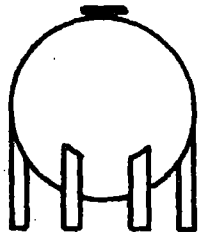
Horizontal Tanks
**STORES: flammable and
combustible liquids,
corrosive liquids, poisons, etc.**

Fixed Facility, Pressurized

As with any tank, pressurized fixed facility tanks will have rounded edges, and may even be perfectly spherical. They can be under very high pressure and usually contain relatively large quantities of gases, liquified gases, or cryogenic materials.



High Pressure Horizontal Tank
STORES: liquid propane gases,
anhydrous ammonia, flammable
liquids with high vapor pressures



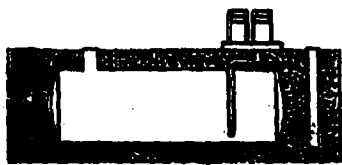
High Pressure Spherical Tank
STORES: liquid propane gases



Cryogenic Liquid Tank
STORES: liquid oxygen (LOX),
liquid nitrogen, and other liquified
gases

Fixed Facility, Underground Storage

Underground storage is very common at fixed facilities. Underground storage tanks can usually be identified by manways, fill pipes, vent pipes, concrete pads with covered fill holes, or electrical cables entering or exiting the ground. These tanks primarily contain petroleum products, and may be extremely large.



Underground Storage Tank
STORES: primarily petroleum
products

APPENDIX 5

Guide to DOT and NFPA PLACARDS

The United States Department of Transportation (DOT) requires transporters to display diamond-shaped placards on the exterior of their vehicles when carrying hazardous materials above certain weight limits. These placards represent the type of hazards presented by the materials being carried, according to the hazard class they fall under. There are nine hazard classes specified by DOT, several of which are subdivided into divisions. These divisions segregate special types of material hazards within a hazard class.

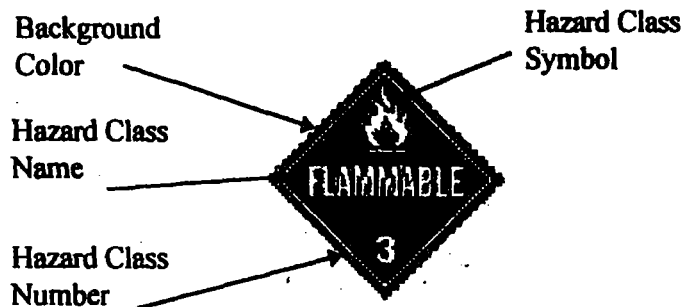
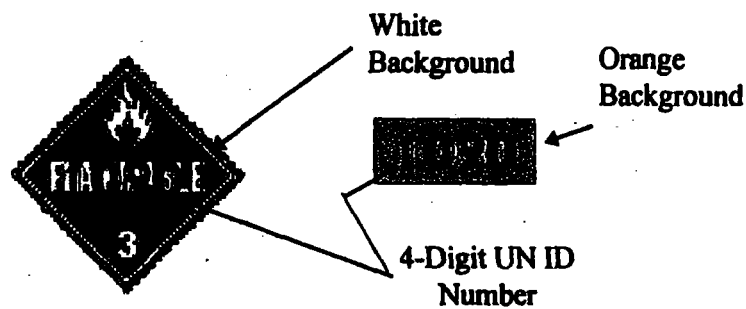
Placards are diamond-shaped markers, 10-3/4 inches on each side, which consist of four major components; the hazard class symbol, the hazard class number, the background color, and (to a lesser degree) the United Nations ID number or the hazard class name. These four components can be used to determine the hazards presented by a material in transport, usually from a safe distance away.

The hazard class symbol is located in the top corner of the diamond and is specific to the hazard presented by the material.

The hazard class number (and the division number for Class 1 and Class 5 materials) is located in the bottom corner of the diamond, and is specific to its hazard class or division.

The background color provides the background for the placard and corresponds to a specific hazard presented by the material.

The hazard class name, as well as the United Nations (UN) ID number, may or may not be present. If the hazard class name is present, it will be located in the center of the placard between the hazard class symbol and the hazard class number. If the UN ID number is present, it will either be located in the center of the placard between the hazard class symbol and the hazard class number, or immediately adjacent to the placard itself. UN ID numbers will be four digits long, and will be black on a white background (if located in the center of the placard) or black on an orange background (if located adjacent to the placard). Keep in mind that neither of these markings may be present. It is therefore important to be familiar with the other placard components.



The following list provides DOT definitions for the specified hazard classes and divisions, as well as examples of the specific placards utilized. Any material which falls into any of these DOT classes will require placarding in transport if it exceeds certain weight limits.

Class 1 (explosives)

Explosive means any substance or article, including a device, that is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or that, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion. Explosives in Class 1 are divided into six divisions. Each division will have a letter designation (located where the * is on the placards). All of these placards have orange backgrounds.



Division 1.1 consists of explosives that have a mass explosion hazard. A mass explosion is one that affects almost the entire load instantaneously. Examples: black powder, dynamite, and TNT.

Division 1.2 consists of explosives that have a projectile hazard but not a mass explosion hazard. Examples: aerial flares, detonating cord, and power device cartridges.

Division 1.3 consists of explosives that have a fire hazard and either a minor blast or a minor projectile hazard, or both, but not a mass explosion hazard. Examples: liquid-fueled rocket motors and propellant explosives.



Division 1.4 consists of explosive devices that present a minor explosion hazard. No device in the division may contain more than 25 g (0.9 oz) of a detonating material. The

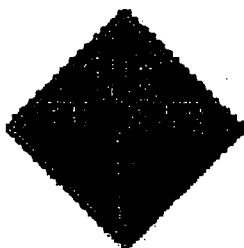
explosive effects are largely confined to the package and no projection of fragments of appreciable size or range are expected. An external fire must not cause instantaneous

explosion of the entire contents of the package. Examples: line-throwing rockets, practice ammunition, and signal cartridges.



Division 1.5 consists of very insensitive explosives. This division comprises substances that have a mass explosion hazard but are so insensitive that there is

very little probability of initiation or of transition from burning to detonation under normal conditions of transport. Examples: prilled ammonium nitrate fertilizer-fuel oil mixtures (blasting agents).



Division 1.6 consists of extremely insensitive articles that do not have a mass explosive hazard. This division comprises articles that contain only extremely insensitive

detonating substances and that demonstrate a negligible probability of accidental initiation or propagation.

Class 2 (compressed gases)



Division 2.1 (flammable gas) RED BACKGROUND COLOR. Any material that is a gas at 20°C (68°F) or less and 101.3 kPa (14.7 psi) of pressure; a material that

has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psi) and that (a) is ignitable at 101.3 kPa (14.7 psi) when in a

mixture of 13% or less by volume with air; or (b) has a flammable range at 101.3 kPa (14.7 psi) with air of at least 12% regardless of the lower limit. Examples: inhibited butadienes, methyl chloride and propane.



Division 2.2
(nonflammable,
nonpoisonous compressed
gas, including compressed
gas, liquified gas,
pressurized cryogenic gas,
and compressed gas in

solution) **GREEN BACKGROUND COLOR.** Any material (or mixture) that exerts, in the packaging, an absolute pressure of 280 kPa (41 psia) at 20°C (69°F).

A cryogenic liquid is defined as a refrigerated liquified gas having a boiling point colder than -90°C (-130°F) at 101.3 kPa (14.7 psi) absolute. Examples: anhydrous ammonia, cryogenic argon, carbon dioxide, and compressed nitrogen.



Division 2.3 (poisonous gas)
WHITE BACKGROUND
COLOR. A material that is
a gas at 20°C (68°F) or less
and a pressure of 101.3 kPa
(14.7 psi or 1 atm), a
material that has a boiling

point of 20°C (68°F) or less at 101.3 kPa (14.7 psi), and that (a) is known to be so toxic to humans as to pose a hazard to health during transportation; or (b) in the absence of adequate data on human toxicity, is presumed to be toxic to humans because, when tested on laboratory animals, it has an LC₅₀ value of not more than 5,000 ppm. Examples: anhydrous hydrogen fluoride, arsine, chlorine, and methyl bromide.

Hazard zones associated with Division 2.3 materials:

Hazard zone A: LC₅₀ less than or equal to 200 ppm.

Hazard zone B: LC_{50} greater than 200 ppm and less than or equal to 1,000 ppm.

Hazard zone C: LC_{50} greater than 1,000 ppm and less than or equal to 3,000 ppm.

Hazard zone D: LC_{50} greater than 3,000 ppm and less than or equal to 5,000 ppm.

Class 3 (flammable liquid)



(Flammable liquid) RED BACKGROUND COLOR

Any liquid having a flash point of not more than 60.5°C (141°F).

Examples: acetone, amyl acetate, gasoline, methyl alcohol, and toluene.

Hazard zones associated with Class 3 materials:

Hazard zone A: LC_{50} less than or equal to 200 ppm.

Hazard zone B: LC_{50} greater than 200 ppm and less than or equal to 1,000 ppm.

A combustible liquid (RED BACKGROUND COLOR) is defined as any liquid that does not meet the definition of any other hazard class and has a flash point above 60°C (140°F) and below 93°C (200°F). Flammable liquids with a flash point above 38°C (100°F) may be reclassified as a combustible liquid.

Examples: mineral oil, peanut oil, and No. 6 fuel oil.

Class 4 (flammable/reactive materials)

Division 4.1 (flammable solid) RED AND WHITE STRIPED BACKGROUND COLOR. Any of the following three types of materials:

- (a) Wetted explosives - explosives wetted with sufficient water, alcohol, or plasticizers to suppress explosive properties.
- (b) Self-reactive materials - materials that are liable to undergo, at normal or elevated temperatures, a strongly exothermic decomposition caused by excessively high transport temperatures or by contamination.
- (c) Readily combustible solids - solids that may cause a fire through friction and any metal powders that can be ignited.

Examples: magnesium (pellets, turnings, or ribbons) and nitrocellulose.



Division 4.2 (spontaneously combustible material) WHITE TOP HALF AND RED BOTTOM HALF BACKGROUND COLOR. Any of the following materials:

- (a) Pyrophoric material - a liquid or solid that, even in small quantities and without an external ignition source, can ignite within 5 minutes after coming in contact with air.
- (b) Self-heating material - a material that, when in contact with air and without an energy supply, is liable to self heat.

Examples: aluminum alkyls, charcoal briquettes, magnesium alkyls, and phosphorus.



Division 4.3 (dangerous when wet material) **BLUE BACKGROUND COLOR.** A material that, by contact with water, is liable to become spontaneously flammable

or to give off flammable or toxic gas at a rate greater than 1 L per kg of the material per hour. Examples: calcium carbide, magnesium powder, potassium metal alloys, and sodium hydride.

Class 5 (oxidizers)



Division 5.1 (oxidizer) **YELLOW BACKGROUND COLOR.** A material that may, generally by yielding oxygen, cause or enhance the combustion of other

materials. Examples: ammonium nitrate, bromine trifluoride, and calcium hypochlorite.



Division 5.2 (organic peroxide) **YELLOW BACKGROUND COLOR.** Any organic compound containing oxygen (O) in the bivalent -O-O- structure that may be considered a

derivative of hydrogen peroxide, where one or more of the hydrogen atoms have been replaced by organic radicals.

Division 5.2 materials are assigned to one of seven types:

Type A - organic peroxide that can detonate or deflagrate rapidly as packaged for transport. Transportation of type A organic peroxides is forbidden.

Type B - organic peroxide that neither detonates nor deflagrates rapidly, but that can undergo a thermal explosion.

Type C - organic peroxide that neither detonates nor deflagrates rapidly, and cannot undergo a thermal explosion.

Type D - organic peroxide that detonates only partially or deflagrates slowly, with medium to no effect when heated under confinement.

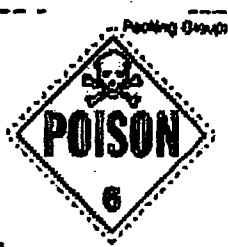
Type E - organic peroxide that neither detonates nor deflagrates, and shows low or no effect when heated under confinement.

Type F - organic peroxide that will not detonate, does not deflagrate, shows only a low, or no, effect if heated when confined, and has low or no explosive power.

Type G - organic peroxide that will not detonate, does not deflagrate, shows no effect if heated when confined, has no explosive power, is thermally stable, and is desensitized.

Examples: dibenzoyl peroxide, methyl ethyl ketone peroxide, and peroxyacetic acid.

Class 6 (poisons)



Division 6.1 (poisonous material) WHITE BACKGROUND COLOR.

A material, other than a gas, that is either known to be so toxic to humans as to afford a hazard to health during

transportation, or in the absence of adequate data on human toxicity, is presumed to be toxic to humans, including materials

materials that cause irritation. Examples: aniline, arsenic compounds, carbon tetrachloride, hydrocyanic acid, and tear gas.

Division 6.2 (infectious substances) WHITE BACKGROUND COLOR. A viable microorganism, or its toxin, that causes or may cause disease in humans or animals. Infectious substance and etiologic agent are synonymous with each other.

Examples: anthrax, botulism, rabies, and tetanus.

Class 7 (radioactives)



(radioactive materials)
**YELLOW TOP HALF,
WHITE BOTTOM HALF
BACKGROUND COLOR.**

A radioactive material is defined as any material having a specific activity

greater than 0.002 microcuries per gram (uCi/g). Examples: cobalt, uranium hexafluoride, and "yellow cake."

Class 8 (corrosive)



(corrosive materials)
**WHITE TOP HALF AND
BLACK BOTTOM HALF
BACKGROUND COLOR.**

A corrosive material is defined as a liquid or solid that causes visible

destruction or irreversible alterations in human skin tissue at the site of contact, or a liquid that has a severe corrosion rate on steel or aluminum.

Corrosivity is measured by pH, which ranges from 0 (highly acidic) through 7 (water, neutral) to 14 (highly basic). Acids attack tissues aggressively. Bases (also referred to as alkaline and caustic) attack tissues less aggressively in general;

however, they are fat soluble and therefore have a greater potential to affect subcutaneous layers.

Examples: nitric acid, phosphorus trichloride, sodium hydroxide, and sulfuric acid.

Class 9 (miscellaneous)



BLACK AND WHITE STRIPED TOP HALF, AND WHITE BOTTOM HALF BACKGROUND COLOR. A miscellaneous hazardous material is defined as a material that

presents a hazard during transport, but that is not included in another hazard class, including (a) any material that has an anesthetic, noxious, or similar property that could cause extreme annoyance or discomfort to a flight crew member so as to prevent the correct performance of assigned duties; and (b) any material that is not included in any other hazard class, but is subject to the DOT requirement (a hazardous substance or a hazardous waste).

Examples: adipic acid, hazardous substances (e.g., PCBs), and molten sulfur.

In summary:

Class 1: Explosives

Orange background, bursting ball symbol

Class 2: Compressed Gases

2.1 Flammable Gas

Red background, flame symbol

2.2 Non-Flammable Gas

Green background, cylinder symbol

2.3 Poison Gas

White background, skull and crossbones symbol

Class 3: Flammable Liquids

Red background, flame symbol

Class 4: Flammable Materials

4.1 Flammable Solids

Red and white striped background, flame symbol

4.2 Spontaneously Combustible

White top half and red bottom half background, flame symbol

4.3 Dangerous When Wet

Blue background, flame symbol

Class 5: Oxidizing Materials

5.1 Oxidizers

Yellow background, burning "O" symbol

5.2 Organic Peroxides

Yellow background, burning "O" symbol

Class 6: Poisonous Materials (other than gases)

6.1 Poisons

White background, skull and crossbones symbol (or corn stalk symbol)

6.2 Infectious Substances

White background, biohazard symbol

Class 7: Radioactive Materials

Yellow top half and white bottom half background, propeller symbol

Class 8: Corrosives

White top half and black bottom half background, test tube pouring liquid on steel rod and hand symbol

Class 9: Miscellaneous

Black and white stripe top half and white bottom half background, no symbol

DOT exempts certain materials from placarding requirements when in transport. These materials are designated "Otherwise Regulated Materials," abbreviated "ORM". Prior to the HM-181 standards, these materials were designated ORM-A, ORM-B, ORM-C, ORM-D, and ORM-E. Today, only the ORM-D materials remain.

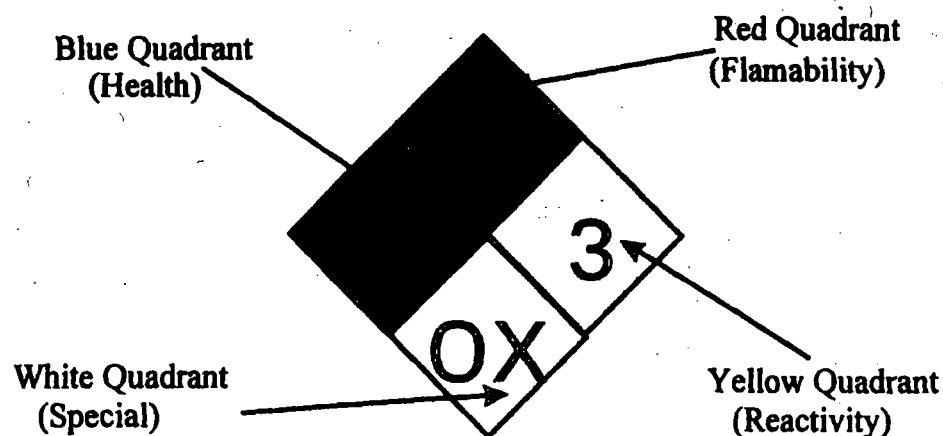
ORM-D Material

An ORM-D material is a material that presents a limited hazard during transportation due to its form, quantity, and packaging.

Examples of ORM-D materials include consumer commodities and small arms ammunition.

The National Fire Protection Association (NFPA) has developed a standardized marking system (704M) designed to be utilized at fixed facilities storing hazardous or flammable materials. This system has been adopted by many industries, and may now be found on small containers as well as large fixed facility containers. The system was originally designed to provide firefighters critical information on the hazards posed by stored materials during firefighting operations. As such, it needed to be large enough to see and concise enough to be quickly discernible in emergency situations.

The NFPA 704 system uses a diamond divided into four different color quadrants. Each quadrant is colored differently, representing a specific hazard. The red quadrant (top) represents a flammability hazard, the blue quadrant (left) represents a health (or toxicity) hazard, the yellow quadrant (right) represents a reactivity (explosion) hazard, and the white quadrant (bottom) is reserved for special hazards. The diamond looks like this:



NFPA 704 Marking System

The numbers in each quadrant of the NFPA 704 system indicate the degree of hazard posed to a firefighter (wearing turn-out bunker gear and

an SCBA) for that particular quadrant. A "0" indicates minimal risk, and a "4" indicates high risk. More specifically, the NFPA designations for the numbers assigned to these quadrants are as follows:

Blue - Health Hazard

In general, the health hazard in fire fighting is that of a single exposure, the duration of which may vary from a few seconds up to an hour. The physical exertion demanded in fire fighting or other emergencies may be expected to intensify the effects of an exposure. In assigning degrees of danger, local conditions must be considered. The following explanation is based on use of the protective equipment normally worn by fire fighters.

- 4 - These materials are too dangerous to health for a firefighter to be exposed. Turn-out bunker gear and an SCBA are not adequate protection from inhalation and skin exposure to this material. Skin contact with the vapor or liquid of this material may be fatal. Inhalation of the vapors of this material may be fatal.
- 3 - These materials are extremely hazardous to health, but fire areas may be entered with extreme care. Turn-out bunker gear and an SCBA may not be adequate protection from inhalation and skin exposure to this material. No skin surface should be exposed and additional protective clothing may be needed.
- 2 - These materials are hazardous to health, but fire areas may be entered freely with turn-out bunker gear and an SCBA. Turn-out bunker gear and an SCBA are adequate protection from inhalation and skin exposure to this material.
- 1 - These materials are only slightly hazardous to health. Turn-out bunker gear and an SCBA are adequate protection from inhalation and skin exposure to this material.
- 0 - These materials, even under fire conditions, pose no additional health hazards over those of ordinary combustible materials. Turn-out bunker gear and an SCBA are adequate protection from inhalation and skin exposure to this material.

Red - Flammability Hazard

Susceptibility to burning is the basis for assigning degrees within this category. The method of attacking the fire is influenced by this susceptibility factor.

- 4 - These materials are extremely flammable gases or extremely volatile flammable liquids. If possible, stop the flow and keep exposed tanks cool. Withdrawal may be necessary.
- 3 - These materials can be ignited under almost all normal temperature conditions. Water may be an ineffective means of extinguishing these materials because of the very low flash point.
- 2 - These materials must be heated slightly before they will ignite. Water may be an effective means of extinguishing these materials because they can be cooled below their flash points.
- 1 - These materials must be preheated before they will ignite. A water fog may be sufficient to extinguish these materials when burning.
- 0 - These materials will not burn.

Yellow - Reactivity (Stability) Hazard

The assignment of degrees in the reactivity category is based upon the susceptibility of materials to release energy either by themselves or in combination with water. Fire exposure was one of the factors considered along with conditions of shock and pressure.

- 4 - These materials are readily capable of detonation or explosive decomposition at normal temperatures and pressures. If they are involved in a massive fire, vacate the area immediately.
- 3 - These materials, when heated or under confinement, are capable of detonation or explosive decomposition and they may react violently with water. Fire fighting should be conducted from behind explosion resistant barriers.

- 2 - These materials will undergo violent chemical change at elevated temperatures or pressures but do not detonate. Firefighting should be conducted from a distance or with portable monitors if possible. Tanks containing these materials should be kept cool. Use caution.
- 1 - These materials are normally stable, but may become unstable in combination with other materials or at elevated temperatures or pressures. Fire fighting can be conducted utilizing precautions normal to any fire.
- 0 - These materials are normally stable and do not present any reactivity hazards to firefighters.

White - Special Hazard

Under the 704 system, a "W" with a slash through it indicates that no water should be used. An "OX" indicates that the material is an oxidizer, and may increase the flammability hazard of other materials. There are some other symbols that may appear in this quadrant, such as:

ALK - This material is corrosive to skin and steel, and is a base (alkaline) material.

ACID - This material is corrosive to skin and steel and is an acid material.



- This material is radioactive.

APPENDIX 6

Integrating Removal and Remedial Site Assessment Investigations

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

Directive 9345.1-6FS
EPA540-F-93-038
September 1993

EPA

INTEGRATING REMOVAL AND REMEDIAL SITE ASSESSMENT INVESTIGATIONS

Office of Emergency and Remedial Response
Hazardous Site Evaluation Division (5204G)+
Quick Reference Fact Sheet

Increased efficiency and shorter response times are the primary objectives of integrating removal and remedial site assessment investigations under the Superfund Accelerated Cleanup Model (SACM). This is based on the assumption that there is duplication of effort between the programs. A critical element of SACM is a continuous and integrated approach to assessing sites. The concept of integrating removal and remedial site assessment activities was introduced in *Assessing Sites Under SACM—Interim Guidance* (OSWER Publication 9203.1-051, Volume 1, Number 4, December 1992). This fact sheet examines areas of duplication and key differences between the two types of investigations, and describes

some approaches for integrating assessments. The primary audience for this information is the site assessment community which includes EPA On-Scene Coordinators (OSCs) and Site Assessment Managers (SAMs), their counterparts in state or other federal agencies, and assessment contractors.

REMOVAL ASSESSMENTS AND REMEDIAL SITE ASSESSMENTS

Figure 1 illustrates traditional assessment activities of the removal and remedial programs prior to SACM. Typically, when EPA is notified of a possible release (under CERCLA Section 103), the removal program determines whether there is a need for emergency response by EPA. If a response is deemed necessary, an OSC and/or a removal program contractor will visit the site. If circumstances allow, a file and telephone investigation should be initiated prior to the site visit. The OSC may decide to take samples during this initial visit or may postpone sampling. EPA can initiate a removal action at any point in the assessment process. If the OSC determines that the site does not warrant a removal action, he may refer the site to remedial site assessment or the State for further evaluation, or recommend no further federal response action.

The remedial site assessment process is similar to that of the removal program. Once a site has been discovered and entered into the CERCLIS data base, the SAM directs that a preliminary assessment (PA) be performed at the site. The focus of PA data collection is the set of Hazard Ranking System (HRS) factors that can be obtained without sampling (e.g., population within ¼ mile). The PA includes a file and telephone investigation, as well as a site visit (the PA reconnaissance, or "recon"). The PA recon differs from the typical removal site visit because samples are not collected and observations are often made from the perimeter of the site (although some Regions prefer on-site PA recons). From the PA information, the SAM determines if a site inspection (SI) is needed (i. e., whether the site could score greater than the 28.5 needed to qualify for inclusion on the National Priorities List (NPL)). The SI would include sufficient sampling and other information to allow the SAM to determine whether the score is above 28.5. Even in cases where SI data are

adequate for this decision, it may be necessary to conduct an expanded site inspection (ESI) to obtain legally defensible documentation.

In general, the remedial site assessment process is more structured than the removal assessment and operates on a less intensive schedule. The remedial site assessment process is focused on collecting data for the HRS, while Removal assessments are based on whether site conditions meet National Contingency Plan (NCP) criteria for a removal action.

INTEGRATING ASSESSMENT ACTIVITIES

While there are differences in objectives between removal and remedial assessments (i.e., NCP removal criteria versus HRS), many of the same factors are important to both programs: the potential for human exposure through drinking water, soils, and air pollution; and threats to sensitive environments such as wetlands. Similarities in the activities required by both assessments—telephone and file investigations, site visits or PA recons, removal or SI sampling visits—suggest that the activities can be consolidated. The challenge of integrating assessments is to organize the activities to enhance efficiency.

The basic goals of an integrated assessment program under SACM are:

- Eliminate duplication of effort.
- Expedite the process. At a minimum, avoid delays for time-critical removal actions or early actions (see *Early Action and Long-Term Action Under SACM-- Interim Guidance*, OSWER Publication 9203.1 - 051, Volume 1, Number 2, December 1992, for details on early and long-term actions).
- Minimize the number of site visits and other steps in the process.
- Collect only the data needed to assess the site appropriately.

The last point is critical to enhancing efficiency since not all sites need to be assessed in depth for both removal and remedial purposes. Integrating assessments does not mean simply adding together the elements of both assessment for all sites—efficient decision points

must be incorporated into the integration process. The elements deemed necessary for an integrated assessment depend on the particular needs of a specific site and could involve similar, additional, or slightly different activities from traditional removal or remedial site assessments.

Figure 2 shows an approach for integrating the two assessments and indicates ways to eliminate unnecessary data collection. The most important features of the approach are the combined notification/site discovery/screening function; the single site visit for both programs; phased file searches as appropriate; and integrated sample planning and inspection. This approach is detailed below.

Notification/Site Discovery/Screening

This "one door" notification process is a combination of the current removal and remedial program notification/discovery. All remedial and removal program discovered sites are screened for possible emergency response. The screening step would determine whether there is time for a file search prior to the initial site visit.

Index

Abandoned tank cars,	45
Absorption,	A99-A101
Additive effects	A106
Air,	A113-A115
American Association of Railroads,	8
Analytical terminology,	A127-129
Antagonistic effects,	A106
APR,	6
ATSDR,	12
Basic data interpretation,	A121-A133
Biological variation,	A102
CAMEO,	10
Centers for Disease Control	8
Chemical Emergency Preparedness Program	8
Chemical storage,	32-33
Chemical mixtures,	A105-A106
Additive effects,	A106
Antagonistic effects,	A106
Potentiation effects,	A106
Synergistic effects,	A106
CHEMTREC	8
CIS	10
Concentration units,	A130
Criteria for removal action,	13-15
Data validation procedures,	A132-A133
Dose vs response,	A103-A104-A105
Drum site,	24-26
Emergency Removal Guidelines	49-70
Environmental media,	A113-A119
Air,	A113-A115
Soils,	A116-A117
Water,	A117-A119
Fire/explosion cene,	22-23

IDLH,	A111
Industrial facility,	37-40
Inhalation,	A98-A99
Injection,	A102
Ingestion,	A101-A102
Laboratory site,	34-36
Lagoon site,	27-28
Landfill site,	29-31
MCL,	A112
National Animal Poison Control Center,	9
National Contingency Plan,	13-18
National Pesticide Telecommunications Network,	9
PEL,	A111
Potential effects,	A106
Preliminary assessment,	13,15,18
Qualitative hazard recognition,	19-47
Abandoned tank cars,	45
Chemical storage,	32-33
Drums site,	24-26
Fire/explosion scene,	22-23
Industrial facility,	37-40
Laboratory,	34-36
Lagoon,	27-28
Landfill,	29-31
Service building/maintenance,	46
Underground storage tank,	44
Warehouse,	45
Removal Action Levels (RALs)	72-91
Removal and Remedial Site Investigation,	A167-A170
RCRA hotline,	9
Routes of Exposure,	A97-105
Absorption,	A99-A101
Inhalation,	A98-A99
Injection,	A102
Ingestion,	A101-A102

Safe Drinking Water hotline	9
Safety,	5-6
Sampling,	A122-A133
Sampling plan,	A122, A123-A127
SCBA,	6
Service building/maintenance site,	46
Site investigation,	13, 15, 18-20
Soils,	A116-A117
Superfund hotline,	9
Synergistic effects,	A106
 Texas Tech University Pesticide Hotline,	 9
TLV,	A110
TLV-C,	A110
TLV-STEL,	A110
TLV-TWA,	A110
Toxicology,	A93-A112
TOXNET,	10
TSCA hotline,	9
 Underground storage tank,	 44
US Department of Transportation Hotline	9
 Warehouse,	 45
Water,	A117-A119